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Naval Research Advisory Committee Report

Science & Technology Community in Crisis

MAY 2002

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DoD Laboratories - Essential & Critical

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14. ABSTRACT

This study requested by the Director, Defense Research and Engineering was motivated by concerns over the continuing difficulties the Department of Defense laboratories are experiencing in recruiting and retaining world-class scientists and engineers. The study panel composed of members from the Naval Research Advisory Committee, the Army Science Board, and the Air Force Scientific Advisory Board, reviewed a multitude of past studies and conducted fact-finding meetings to arrive at their conclusions. The Panel had six findings. 1) The role of DoD laboratories in the future is both essential and critical. 2) A characteristic of world-class laboratories is highest quality scientists and engineers. 3) Few recommendations from previous studies have been implemented. 4) Congress recognizes the problems and has tried to help. 5) Immediate action and sustained commitment from OSD and Service leadership is required now and in the future. 6) Further inaction would be irresponsible. The Panel then made three recommendations. The first recommendation was to obtain commitment of the importance and value of the laboratories. The second recommendation was to use existing authority to establish a separate personnel system for scientists and engineers. The third recommendation was to seek additional legislation to allow experiments for the laboratories test alternative governance structures.

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DoD Laboratories - Essential & Critical

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1. EXECUTIVE SUMMARY

This study was conducted under the leadership of the Naval Research Advisory Committee (NRAC) with participation by the Army Science Board (ASB) and the Air Force Scientific Advisory Board (AFSAB). Panel membership is shown in Appendix A. The study was requested by the Director, Defense Research and Engineering (DDR&E), and was motivated by concerns over the continuing difficulties the Department of Defense (DoD) laboratories[1] are experiencing in recruiting and retaining world-class scientists and engineers (S&Es). The problem has been worsened by reduced personnel recruitment in the 1990s, which has resulted in a significant increase in the average age of the technical workforce at these organizations. In addition, most of these laboratories now have significantly fewer S&Es under 30 years of age, thereby creating a worrisome demographic gap in their staffs. The growing number of retirements that are expected in the coming decade will further exacerbate this problem to the level of a crisis.

The DoD laboratories and centers have been the subject of many earlier studies, some dating back to the 1950s and 60s. In recognition of this, the study Terms of Reference (TOR) did not call for an entirely new study of the issues. Rather, the TOR tasked the NRAC Panel with reviewing the conclusions of the most important past studies and identifying what actions should be taken to ensure the excellence of these laboratories. After reviewing the results of past studies, the Panel agreed that this subject area has been exhaustively investigated by a long series of blue-ribbon panels and that most of their findings were still valid. The complete TOR is attached as Appendix B.

During the course of the study, the Panel was briefed by a variety of experts in the field of S&E recruitment, reward, and retention, as well as laboratory directors from academia, industry, other government, and Federally Funded Research and Development Centers (FFRDCs). In accordance with the TOR, the Panel considered at some length what the mission of the laboratories should be in the 21st Century, given their status today and the likely future threat environment.

Findings

Based on its analysis, the Panel formulated a series of findings and associated recommendations summarized as follows:

- **Role of the DoD laboratories in the future: <u>essential and critical</u>**
  - Most of industry invests little in basic research.
  - At the same time, the diversity and number of future threats is increasing, ranging from sophisticated "Axis of Evil" countries to independent terrorist cells; from intercontinental ballistic missiles to chemical and biological agents.
  - Industry will pursue high-profit major weapons systems — but the laboratories are crucial to address high-risk, low-volume Science and Technology (S&T) projects, like those that developed the atomic clocks that enabled the development of the Global

[1] The focus of this report is on the laboratories and technical centers owned and operated by the Department of Defense and staffed with Federal Government employees. These are sometimes called "in-house" laboratories or centers to distinguish them from other DoD-funded technical activities such as Federally Funded Research and Development Centers.

Positioning System (GPS), the explosive chemistry that resulted in the thermobaric bomb, and countless others.

- It is crucial that the focus on defense-unique technologies be continued: the ability to see inside buildings and caves; remotely detect and identify threats; neutralize mines and chemical and biological agents.
- Also, as the technological sophistication of defense systems continues to increase, so too does the requirement for in-house technical experts who can advise acquisition program managers (PMs) on technical feasibility, affordability, etc. of proposed solutions.

- **The characteristics of a world-class laboratory: the highest quality scientists and engineers**
  - Highest quality staff — smart, creative, challenged, dedicated S&Es
  - Strong leadership
  - Adequate facilities and equipment
  - Good support services responsive to laboratory needs

- **Past studies of the laboratories: mostly well done, but few of their recommendations implemented**

More than 100 studies of the laboratories have been conducted over the past 30 years. They generally endorsed the requirement for world-class in-house laboratories, and made remarkably consistent recommendations for reforms:

- The laboratories are an essential component of the war-fighting machine of the United States (U.S.).

- Unless they receive help soon (at the Service, Office of the Secretary of Defense (OSD), and Congressional levels), they will no longer be able to recruit and retain the high quality, dedicated scientists and engineers required to perform the research necessary to preserve our military's technological superiority.

Regrettably, the fate of recommendations from past studies has been uniformly consistent in that little effective action has been taken to implement them. Although several ambitious "demonstration" programs were established, they encountered significant organizational resistance that hindered reform. Consequently, the negative consequences of inaction predicted by past studies are now beginning to appear at most laboratories.

Given this record, several recent DSB studies made the *a priori* assumption that the Federal "system" can't be reformed and, therefore, recommended staffing the laboratories with contingent personnel (e.g. limited-term appointments or academics brought in under the Intergovernmental Personnel Act (IPA)), or converting the laboratories to alternative governance systems, such as Government-Owned, Contractor-Operated (GOCO) activities. While these remain options that could be considered, the Panel felt that there are others that could really solve most of the problems identified. The Panel considers it imperative that the DoD and Service leadership recognize the unique requirements confronting the laboratories, and implement real reforms to address them.

- **Legislative initiatives: Congress recognizes the problems and has tried to help**

Congress has repeatedly given DoD the tools to fix many of the problems confronting the laboratories! Without a sustained, high-level, commitment in OSD and the Services to see that these tools are used aggressively, most have languished unused or underutilized.

- **Strategy: Immediate action and sustained commitment from OSD and Service leadership is required, both now and in the future**

OSD must take measures to make maximum use of the Section 1114 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 01 authorities granted by Congress, and also develop/propose additional legislation to resolve other problems not addressed by Section 1114, and do both as quickly as possible. Specific actions to be taken have been adequately documented in the past and are summarized in the body of this report. Again, Congress has already provided many of the necessary authorities to begin the job.

- **Responsibility: Inaction would be irresponsible**

The time has come to listen to the conclusions of the many distinguished people who have served on past studies of the laboratories, and to implement the actions they have recommended to remove the burdens of an unresponsive bureaucratic system from one of the most important components of U.S. military superiority. What is needed now is a sustained commitment to fix the problem.

Recommendations

- **Recommendation 1: The Panel recommends that the Director, Defense Research and Engineering obtain the commitment of the Secretary of Defense and the Service Secretaries to the need for, and the importance and value of, the Service Corporate Research Laboratories by their demonstrating continuing support for the implementation of Recommendations #2 and #3 listed below.**

Leadership commitment at the highest possible levels is essential to preserve the critically needed S&E staffs in the DoD research laboratories. In carrying out its work, the Panel focused on the three Service corporate laboratories: Air Force Research Laboratory (AFRL), Army Research Laboratory (ARL), and the Naval Research Laboratory (NRL), because they are the primary source of discovery and invention for their respective Services. Without new breakthroughs in science and engineering, there will be no advances in such critical defense areas as sensors, weapons, and propulsion. There are no commercial or industrial requirements to locate mines or submarines or to see into mountain caves — so industry will not invest in such high-risk, low-profit areas for commercial purposes. Nor are universities likely to fill this gap because of reluctance to undertake classified work, and/or make necessary investments in equipment and facilities, etc. The important role of the DoD laboratories must be recognized and endorsed by the senior leadership of the DoD and Services — **to do otherwise is to guarantee future failure.**

- **Recommendation 2: The Panel recommends that the Secretary of Defense fully utilize the authority granted him by Section 1114 of the National Defense Authorization Act (NDAA) of Fiscal Year 2001, and any other authorities granted by Congress, to establish a separate personnel system for the scientists and engineers in the Services' corporate laboratories.**

Congress has recognized the criticality of this issue and, in FY 01 NDAA Sec 1114, provided the Secretary of Defense (SECDEF) with the Office of Personnel Management's (OPM) authorities for personnel demos in the DoD laboratories. OSD and the Services must take action to use what has already been given to them — or the OPM will (as they are trying to do) get this authority rescinded. This is an opportunity that must be acted upon now. It is an immediately available stopgap measure.

- **Recommendation 3: The Panel recommends that the Director, Defense Research and Engineering develop and propose to Congress additional legislation that would enable the Services to experiment with alternative governance structures that would address additional laboratory issues such as salary caps, facility and equipment renewal, and laboratory director authority.**

OSD and the Services should immediately take action to develop and propose additional legislation to comprehensively address the issues confronting the laboratories — salary caps, burdensome procedures, inability to renew facilities and equipment, lack of laboratory director authority, and poor support services.

2. INTRODUCTION AND BACKGROUND

The Defense establishment of the U.S. has invested in militarily relevant research and development (R&D) for more than 100 years. The three military Services own and operate an extensive network of research, development, test, and evaluation (RDT&E) laboratories and centers devoted to supporting their missions, and the acquisition, upgrade, and operation of war-fighting systems. Some of these laboratories/centers trace their origins back to the 1800s, though most are descendents of research and test activities first established during World War I or World War II. As such, they are integral components of their Services and support their respective research, development, and acquisition (RDA) process. They have a rich history, with most having evolved from small, specialized laboratories and centers focused on a particular component or weapon, to today's warfare-oriented centers that perform work ranging from basic science and technology, all the way to the support of systems already in military service.

Although often collectively referred to as "laboratories," these activities actually have many formal titles, such as warfare center; systems center; research, development and engineering center (RDEC); test and evaluation (T&E) center; engineering center; experiment station; research laboratory; and research center. In most cases, the formal titles are more accurate representations of the kind of work conducted at these activities than the term "laboratory." For although all of these activities receive some level of RDT&E (Category 6) funding, and may even do some S&T [defined to include Basic Research (6.1), Applied Research (6.2), and Advanced Technology Development (6.3)] work, many are really not "research" laboratories as

the term is commonly understood. In fact, most of these RDT&E activities conduct very little S&T effort. Rather, most of their effort is devoted to technical support to Service acquisition organizations, systems engineering, in-service engineering, and interoperability and software support. These technical centers are sometimes generically referred to as "product" centers because they are more closely associated with end products such as platforms (ships, aircraft, etc.) or war-fighting areas (surface warfare, undersea warfare, etc.).

Nevertheless, because they all employ large numbers of S&Es, it has become common to refer to them collectively as laboratories, and think of them as a homogenous group with similar attributes and facing similar problems. Close examination, however, shows this to be both a gross oversimplification and rather misleading.

Corporate Laboratories vs. Product Centers

There are important differences between the functions of corporate research laboratories and the product centers:

- Corporate laboratories are predominantly or totally devoted to S&T work (6.1, 6.2, 6.3).
- Product centers are predominantly funded by higher categories of RDT&E (6.4 - 6.7) as well as by Procurement and Operations and Maintenance (O&M) funding.
- Corporate laboratories have a much higher percentage of PhDs.
- Corporate laboratories are more focused on science.
- Product centers are more focused on engineering.
- Product centers often do in-service engineering, systems engineering, and provide interoperability and software support.
- Product centers are more likely to provide direct technical support to operational commands.

The term "RDT&E activity" is also frequently used interchangeably with the term laboratory, although the former has a rather specific meaning. In fact, the Office of the Deputy Under Secretary of Defense for Science and Technology publishes an annual "In-House RDT&E Activities Management and Analysis Report" that compiles financial, personnel, and program data. In this context, an "In-house RDT&E Activity" is an organization owned and operated by one of the Services in which a minimum of 25 percent of the in-house manpower and/or 25 percent of the activity's funding is devoted to research, exploratory or advanced development, engineering development, etc., conducted in-house.[2]

Differences Among the Military Services

Since the end of World War II, defense laboratories and centers have played a crucial role in solving science and engineering problems, and in meeting needs unique to the US military. One of their primary purposes is to develop new technologies that support their respective Service missions. In this regard, it should be noted that each of the Services employs a different RDA process. Each is a product of its own historical origins and culture. Service-to-Service differences among the laboratories and centers often lead to confusion and debate at all levels, for example, when Congress tries to compare such basic attributes as the cost of doing business

[2] The Laboratory Management In-House RDT&E Activities Annual Reports may be found on line at http://www.dtic.mil/labman/projects/docs.html

among the Service in-house laboratories. Importantly, it also makes it difficult to craft reform packages, either within DoD or in Congress, that will apply equally well to all of the Service laboratories.

The financial operation of the DoD laboratories will not be addressed here other than to point out one basic difference, which is that the Department of the Navy (DON), unlike the other two Services, operates its laboratories and centers on an industrial funding basis called the Navy Working Capital Fund (WCF).[3] Under the WCF approach, the DON laboratories and centers recover a proportional share of all operating costs from their customers in the same manner (e.g., through overhead charges) as does industry. This allows for a full accounting of the actual cost of doing a particular piece of business. Charges to customer accounts include the direct cost of performing the work and all of the organization's overhead, including maintaining the physical plant and other services such as supply, finance, and command support.[4] The Air Force operates its laboratories and centers on an institutionally funded basis. That is, their overhead costs are funded through direct appropriations from the Congress. The ARL and the Army RDECs operate on a combination of direct appropriations and partial overhead reimbursement. (The Army Corps of Engineers centers, not addressed in this study, operate on a revolving-fund basis that is similar to the Navy WCF). This difference often means that doing work at an Army or Air Force laboratory is cheaper for the customer paying for the work; but when considering total cost to the taxpayer, this may not be the case.

Differences such as these also mean that the functions of the in-house laboratories vary from Service to Service. This too makes cross-Service comparisons exceedingly precarious, a point made in a 1991 report by the Congressional Research Service: "*comparing the defense laboratories among themselves can be difficult since no two are alike. They differ in the subject areas they focus on, the mix among categories of work (e.g. the proportions of basic, applied, and development activities each performs), and the weighting of their missions among a number of basic tasks. Clearly, the differences among the Services' laboratories make evaluation and comparative analysis difficult to achieve*."[5]

Origins of this Study

The DoD laboratories and product centers, and their predecessor activities, have been the subject of numerous studies for more than 40 years. A recurring theme in most of these studies was that these organizations (particularly those focused on S&T) were having increasing difficulty recruiting and retaining scientific and engineering staff. By the 1980s, this malaise was spreading to other, non-research-oriented government organizations. In 1989, the National Commission on the Public Service started a national debate on what it called the "quiet crisis" in government. The Volcker Commission (named after Paul Volcker, former chairman of the

[3] A basic discussion of these financial differences can be found in the Report of the Laboratory Quality Improvement Program (LQIP) Financial Subpanel, "Recommendations For A Common Financial Management Approach At The DoD Laboratories," submitted to the LQIP Implementation Panel, Office of the Director, Defense Research and Engineering, April 1996.

[4] It should be noted that a few of the DON laboratories and centers involved with the testing and evaluation of full-scale systems receive limited institutional (Major Range and Test Facility Base) support for some test ranges and facilities. A few also receive a small amount of base operating support.

[5] Congressional Research Service Report for Congress. "Defense Laboratories: Proposals for Closure and Consolidation," 24 Jan 1991.

Federal Reserve Board) included some of the country's most distinguished public servants, including former President Gerald Ford, former Vice-President Walter Mondale, Robert McNamara, Elliot Richardson, and Donald Rumsfeld. In the following statement, they targeted the central issue — the quality of the public service:

> *"The resulting erosion in the quality of America's public service is difficult to measure; there are still many examples of excellence... Nevertheless, it is evident that the public service is neither as attractive as it once was nor as effective in meeting perceived needs... The erosion has been gradual, almost imperceptible, year-by-year. But it has occurred nonetheless".*[6]

The Commission succeeded in starting the debate, but it did not endure, and the resultant erosion in pride in public service is a major problem as Federal government activities attempt to hire a new generation of civilian employees. This subject is discussed in more detail later in this report. As will be seen, Volker's study wasn't the first or the last on this subject.

Concern about the state of the Federal personnel system has sharpened recently as reports and articles on this subject have begun appearing in the national media. In February 2000, the DSB issued a report that concluded that the DoD does not have the authority and tools necessary to integrate the management of its human resources and that a one-size-fits-all core personnel management system with rules set by the OPM limits the effectiveness of the civilian workforce.[7]

Responding to the opportunities afforded by this increased attention, in 2001 the office of the DDR&E requested the Chief of Naval Research (CNR) to charter a group to take a fresh look at the issue and describe what actions would be required to make the DoD in-house S&T community competitive with other employers for "world-class" science and engineering talent. It should be noted that DDR&E is the part of OSD that is responsible for coordinating the planning and execution of S&T work within the DoD, and has played a significant role in the administration of many previous attempts to improve the quality of the in-house laboratories and centers.

In response to the DDR&E request, the CNR chartered a study by the NRAC of the problems confronting the S&T laboratories. The NRAC was established by the same statute that created the ONR in 1946; the CNR serves as the executive director of NRAC.

By design, this study was to focus on the S&T laboratories operated by all three Services, so participation by members of the ASB and AFSAB was essential. A listing of the Panel members is attached as Appendix A.

Terms of Reference

Also by design, the study was to focus on the crisis confronting the organizations conducting the bulk of the S&T work in house; i.e., the three Service corporate laboratories. The title assigned to the study by DDR&E and the CNR was "Science and Technology Community in Crisis." The

[6] The National Commission on the Public Service, *Leadership for America: Rebuilding the Public Service*, 1989.
[7] Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, *The Defense Science Board Task Force on Human Resources Strategy*, February 2000.

TORs were approved by DDR&E, NRAC and the CNR during the fall of 2001, and identified the crisis confronting the in-house S&T community as having been caused by a number of factors, among which are:

- Difficulty recruiting and retaining world-class scientists and engineers.
- An inability to renew aging facilities and equipment.
- An aging workforce caused by years of downsizing, hiring freezes, and very limited recruiting.
- Changes in the roles of the laboratories themselves, caused by consolidations, closures, increased outsourcing, a lack of stability in their R&D programs, transfers of headquarters functions, and a rapidly evolving world economy.

The above-listed factors have left the DoD with a very different laboratory structure than it had at the end of the Cold War — so the TOR tasked the Panel with identifying:

- What the role(s) of the DoD laboratories should be in the 21st Century, given their situation today; and
- The characteristics of a world-class laboratory in terms of professional staff, infrastructure, budgeting process, support services, etc.

The TOR also recognized that these issues had been addressed by many previous studies, and therefore, did not require the Panel to go over the same ground again. Rather, it directed the Panel to consider the laboratories in the light of the needs of the DoD in the 21st Century, and revalidate those recommendations from previous studies that would permit the laboratories to achieve world-class status. The direction was to:

- Review the most relevant and important past studies of the laboratories to assess the current relevance of their primary recommendations.
- Assess the benefits of those that were implemented and the continued applicability of those not adopted.
- Prioritize those that promise the greatest potential for attracting and retaining a world-class scientific and engineering staff.
- Identify possible reasons for past inaction, and recommend approaches to improve the opportunities for favorable action.

The TOR also tasked the Panel to assess the implementation status and impact of recent legislative initiatives directed toward improving the DoD laboratories.

Finally, the TOR directed: "Assuming that future roles for these organizations can be identified, recommend both near-term steps and a long-term strategy for ensuring the excellence of the Service S&T laboratory system for the next 25 years. As a minimum, address the following areas:

- S&E recruitment, reward and retention;
- Laboratory facilities, equipment and infrastructure;
- Support services quality and control; and

- Identify any Service-unique approaches."

A copy of the TOR is attached at Appendix B.

3. STUDY EXECUTION

Given the focus on in-house S&T laboratories in the TOR, the Panel decided it should devote all of its energies to the three aforementioned corporate laboratories, and then consider the degree to which desired reforms could be exported to other RDT&E laboratories and centers.

The Panel approach was as follows:

- Five two-day meetings, October 2001 - March 2002 .
- Meetings included one-day visits to each of the three corporate laboratories:
  - NRL Washington, DC; ARL, Adelphi, Maryland; AFRL, Wright-Patterson Air Force Base, Ohio.
  - Received briefings at each on laboratory programs and personnel demonstration programs.
  - Met with three groups at each laboratory to discuss S&E recruiting and retention problems and challenges: senior managers, middle managers, and new hires/post doctorates.
- Overview briefings by DoD senior leadership:
  - DDR&E.
  - Service S&T Executives.
  - President, National Defense University.
  - Commander, Air Force Material Command.

Specific subjects covered included:

- Characteristics of a world-class laboratory.
- Role of the DoD laboratories in the 21st century.
- Recent laboratory-related studies by DSB, Air Force, National Academy of Public Administration (NAPA), RAND Corporation, and others.
- How non-DoD laboratories handle S&E recruitment, retention, and reward:
  - Department of Energy (DOE).
  - National Aeronautics and Space Administration (NASA).
  - University-Affiliated Research Centers (UARCs).
  - FFRDCs.
- Discussions with past DDR&Es, their staffs, and Congressional staff regarding previous attempts to address similar issues.
- Reforms permitted by existing legislative authorities and the degree to which they are being exercised.
- Discussions with experts in the fields of private-sector S&E recruitment and reward.

Copies of the Panel meeting agendas are compiled in Appendix C. A complete listing of those with whom the Panel met is in Appendix D.

4. HISTORICAL REVIEW

The current family of Service RDT&E activities are the descendents of a much more extensive network of laboratories and centers that reached its zenith during the early 1960s, and has since undergone a series of consolidations, closures, mission purifications, and downsizings. In particular, the end of the Cold War triggered a major round of consolidations in the 1990s that will reduce the staffing at these activities by about 50% between FY 90 and FY 05. Figure 1 displays the reductions achieved during the FY 90 to 99 period at the 37 Service organizations defined by the DDR&E as "in-house DoD RDT&E activities".

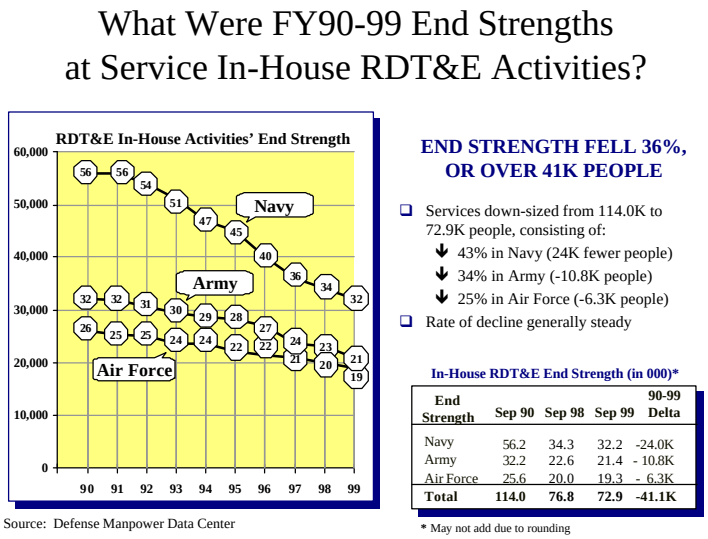

Figure 1: Laboratory Downsizing in the 1990s

Previous Studies of the Laboratories

As noted above, the current network of Service laboratories and centers are the successors to a larger group of activities that evolved out of World War II. As technology and the threat environment evolved in later years, the DoD laboratories and centers were reorganized on a number of occasions to better respond to these requirements. In addition, as early as the early 1960s, evidence began accumulating that Federal Government personnel and procurement regulations and procedures were hindering the ability of the DoD and/or all Federal laboratories to attract and retain quality personnel, build and modify facilities, and respond in a timely manner to the demands of the R&D programs they were funded to execute. In response, the Federal Government, the DoD, and the Services commissioned studies intended to identify impediments to laboratory productivity and develop the means to resolve them. Depending on the definition applied, between 25 and 110 separate studies of some aspect of the Defense R&D establishment were conducted between 1961 and today. Appendix E is a bibliography of reports, studies, and briefings germane to this study of the S&T community. It includes those studies that included a substantive discussion of DoD laboratory health and problems.

Among the most important and prescient of these studies were:

- The 1962 President's Commission of Government R&D Contracting study, known as the "Bell Report" after its chair, David Bell, Director of the Bureau of the Budget. [8] DoD's representative was Robert McNamara, then SECDEF.

- The 1980 study on Required In-House Capabilities for DoD RDT&E, known as the "Perry Report" after its chairman, William Perry.[9]

- The May 1983 Report of the White House Science Council Federal Laboratory Review Panel, known as the "Packard Report" after its chairman, David Packard.[10]

- The Defense Science Board (DSB) 1987 Summer Study on Technology Base Management.[11]

Not all of these studies focused solely on the DoD laboratories, but all included them in their area of study to some extent. Problems identified included:

- Salaries/benefits for top S&Es well below industry and academia.
- Excessive administrative burdens and micromanagement.
- Budget inadequacy/instability.
- Aging/substandard facilities.
- Erosion of pride in public service.

Proposed solutions included:

- Direct-hire authority for laboratory directors for S&E positions.
- Modify Civil Service system to improve workforce shaping (hiring/firing).
- Increase pay (variety of mechanisms proposed).
- Alternative governance schemes, e.g. GOCO.
- Obtain staff from academia, industry, UARCs.
- Create an OSD-level champion for the laboratories.

Most, but not all, of these were exhaustive "blue ribbon" studies, led and staffed by high-ranking people from academia, industry, defense and other government agencies who clearly took their assignment seriously and tried to do what was right. While these studies varied in the scope of their subject matter and the depth of their analyses, most reached similar conclusions and made remarkably similar recommendations. For example, most found that the efficiency and technical productivity of the laboratories were being severely constrained by a multiplicity of Federal

[8] Bureau of the Budget: "Report to the President on Government Contractors for Research and Development (Bell Report), 30 April 1962.
[9] Office of the Under Secretary of Defense for Research and Engineering: "Required In-house Capabilities for Department of Defense Research, Development, Test and Evaluation, " (Perry Report), 1 Oct 1980.
[10] White House Science Council: "Report of the White House Science Council; Federal Laboratory Review Panel," (Packard Report), May 1983.
[11] Defense Science Board: "Report of the 1987 Summer Study on Technology Base Management," 1987.

Government rules and regulations, many based on statutes, that were intended to apply to more "usual" Governmental functions**.**

More specifically, nearly all of those focused on the laboratories and centers noted that the Civil Service procedures and regulations governing civilian personnel matters were seriously impeding the ability of these organizations to attract, recruit, reward, and retain world-class S&Es. Most recommended streamlining various administrative requirements and procedures, and granting activity technical directors increased managerial authority in the area of civilian personnel. Both the 1983 White House Science Council Federal Laboratory Review Panel and the 1987 DSB 1987 Summer Study on Technology Base Management noted that the unique requirements and problems of the DoD laboratories made the standard Federal strictures especially onerous, and recommended that a series of relatively radical measures be taken to exempt the laboratories from many of their requirements.

Impediments to Reform

Despite the very substantial investment of Federal dollars in these studies, and the blue ribbon nature of most of the study panel members, very few of the recommendations made by these groups have ever been implemented. Reasons for this are many and varied, but only a few are really important:

- The Federal "system" (i.e., Federal Personnel Manual, Federal Acquisition Regulations, etc.) is generally based on statutes (which require considerable effort to change) and is structured to employ clerks and administrative personnel (not physicists) or procure spare parts (not scanning electron microscopes or complex studies of sonar system performance). When confronted with a complex, difficult issue, Federal rules tend to hinder, rather than expedite, the process. R&D laboratories, by their nature, tend to stretch to the breaking point the limits of the Federal rules governing scientific personnel recruitment and remuneration, procurement of exotic equipment and services, construction and updating of sophisticated laboratory facilities, and a number of other areas. In other words, the Federal "system" simply finds it very difficult to make the needed changes.

- It is not clear that the elected or appointed leadership understands that the Defense laboratories must be world-class, and that they cannot hope to achieve and retain that status if forced to operate within the stifling array of personnel, procurement, and support service strictures and regulations that significantly impair their ability to perform their missions.

- Those with power and responsibility in Government generally act cautiously and conservatively vis-à-vis granting exceptions to the existing system, in part because they may be concerned about the “camel’s nose under the tent” problem. That is, they worry that once an exception (no matter how justified) to a rule is granted, then other exceptions will surely follow and the system will become more difficult to administer.

- As a general rule, high-ranking appointees tend to have limited time for issues such as these, and so tend to focus their energy on goals perceived to have a near-term payoff, and on the inevitable “fire drills” they face. The fact is they generally have little time to understand the details of complex, bureaucratic problems, especially those that may take years to solve.

Such problems, therefore, devolve to subordinates to resolve, and they have little, if any, incentive to do so. In addition, they often lack the power or authority to see them through to completion.

- Finally, there is an inherent reluctance in any bureaucracy to “take the heat” that might result from decisions that admit that some activities or organizations require special treatment. The result is a tendency toward "one-size-fits-all" solutions that only incrementally depart from the status quo. Even attempts to solve problems through "demonstration" and “pilot” programs that authorize the limited use of simplified, streamlined, or experimental procedures often become crippled or untenable when the participating population is expanded to include all worthwhile organizations instead of a small subset.

There are other factors that have complicated efforts to implement the recommendations made by previous studies of the DoD laboratories:

- The world situation, the threat environment, and the U.S. business environment have all changed substantially since the end of the Cold War and even more so since 9/11/01.

- The entire DoD RDT&E enterprise was reorganized and substantially downsized by a series of Base Realignment and Closure (BRAC) rounds, laboratory consolidations, and hiring freezes that began in the late 1980s.

- The number of U.S. citizens graduating with degrees in science and engineering is declining, while the demand for such trained people continues to increase.

- Reforms or demonstration projects intended to benefit the whole RDT&E community often do not produce the desired results due to:
  - The substantial differences between the way each of the three Services organizes, tasks, and funds its Corporate laboratories; and
  - The differences between the Service corporate S&T laboratories and their product centers.

The impact of each of the above factors will be briefly discussed in the following paragraphs.

The Post-Cold War Environment

Undeniably, the collapse of the Iron Curtain triggered sweeping changes almost everywhere in the world. In the early 1990s the Defense budget was reduced substantially, and S&T in such areas as anti-submarine warfare was severely curtailed. Now, however, the growing threat of terrorism is once again pushing the Defense budget back up, and new S&T areas such as nano-electronics, neural networks and biomolecular engineering are in the spot light.

Many other changes unrelated to the threat environment have also affected the DoD laboratories and centers. For example, technical areas once dominated by Defense, such as information technology (IT), electronics, and telecommunications, are now driven by the commercial market. The DoD now finds itself following, rather than leading, in such areas. This is both a curse and a

blessing. Certainly, the extraordinary progress made in IT as symbolized by Moore's Law could not have been sustained by Defense requirements alone. The U.S. Defense establishment has greatly benefited from the availability of the reliable, ever-more-powerful, ever-less-expensive, computers that were created for the commercial marketplace. On the other hand, few companies will make significant long-term research investments in areas for which DoD is likely to be the only customer. As a result, in such areas as sensors, energetics, ballistics, armor, submarine materials, and many others, Defense must carry the whole burden from basic research almost up to the point of production.

Consolidations in the defense industrial base have also reduced the vast network of suppliers of high-technology systems to a few very large contractors that themselves have few customers except DoD. Fragmentation of the commercial marketplace and foreign competition has caused the dissolution of such great U.S. industrial research laboratories as Bell Telephone Laboratories. With a few notable exceptions (e.g., pharmaceutical industry), most of the corporate research laboratories that remain are focused on relatively short time-horizon product development, rather than the long-term basic research that used to be the forte of U.S. industry. As a result, the Service corporate laboratories are among the few laboratories remaining in the U.S. that are willing to pursue a promising avenue of research for decades, as long as the work continues to have the promise of a significant application to a known or anticipated military need.

The BRAC Era

The DoD laboratory/center structure was almost completely re-made during the decade of the 1990s. There were several specific triggers for this:

- Congress authorized several rounds of BRAC in Fiscal Years 88, 91, 93, and 95. Several of these included specific studies of excess laboratory/center capacity.
- In 1989, OSD approved Defense Management Review Decision (DMRD) 922, which directed the Services to develop and implement plans to consolidate their RDT&E activities to reduce overcapacity and redundant infrastructure and generate specific savings targets.
- As part of a general DoD downsizing, the entire RDT&E community had to meet various staff-reduction targets through the decade. These were imposed by both Congress and the Administration, and averaged about 4% per year.
- On several occasions over the past 15 years, Congress directed OSD and the Services to prepare plans for laboratory/center consolidation.
- The Office of Management and Budget (OMB), OSD, and the Services have all directed greater contracting out (outsourcing) of work to the private sector at various times. Originally, these efforts were focused on support services and other commercial functions, but in recent years, there has been growing pressure to outsource higher-level functions such as RDT&E.

The above direction, combined with falling budgets brought about by the end of the Cold War, provoked a lengthy round of laboratory/center consolidations, transfers, site closures, downsizings, reorganizations, and a focus on purifying the missions (i.e., eliminating duplication and overlap of assigned mission areas) of individual laboratories.

Other means were also used to downsize the laboratories and centers. For example, various types of hiring freeze (e.g., total freeze, 2 hires for every 5 losses, high grades only) were imposed on the DoD and/or the whole Federal Government between 1988 and 1993, with some Service-unique freezes extending into 1999. While conceptually very attractive, hiring freezes are very insidious in their long-term effect. By preventing the recruitment of new hires (who are generally much younger than those departing), they create a demographic void in the workforce and cause its average age to increase, as shown by Figure 2.

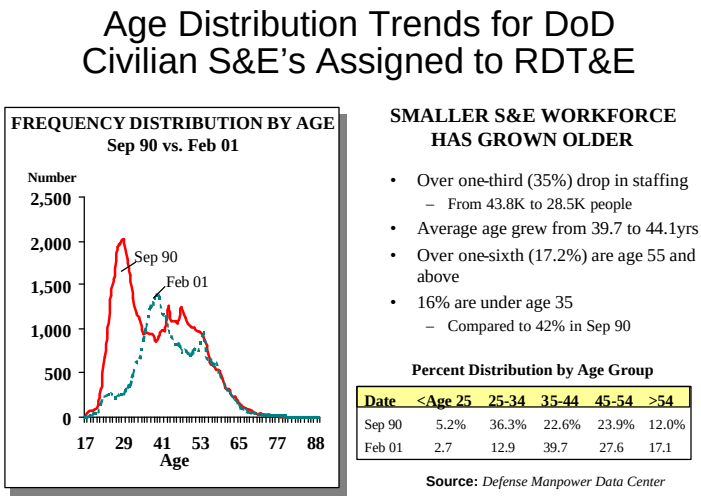

Figure 2: Laboratory/Center Demographic Trends

As a further example, Figure 3 vividly illustrates what has happened to the population of young S&Es in the DON technical community as the result of the hiring freezes and other workforce constraints imposed since the end of the Cold War.[12] The data show a 78% decline in the number of S&Es aged 30 or less employed by the Navy laboratories and centers between FY 91 and FY 00. The Army and Air Force RDT&E activities show a similar decline in the number of young S&Es.

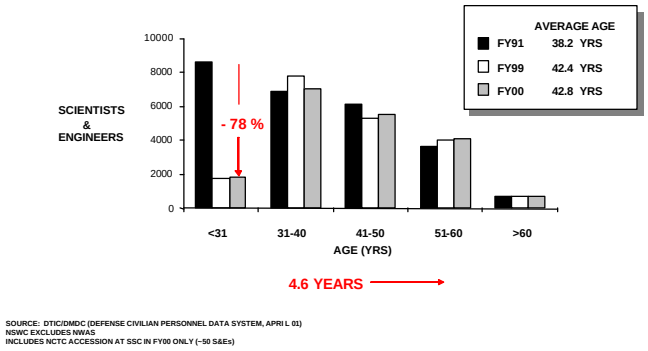

Figure 3: Loss of Young S&Es in the Navy Laboratories and Centers

[12] Data provided by Gary M. Hess, Executive Secretary of the Navy Laboratory/Center Coordinating Group (NLCCG).

The important point is that, if action is not taken within the next few years to correct this graying of the workforce, the DoD laboratories are on course for a demographic train wreck by the end of the decade.

Graduation Rates and the Labor Market

Much has been written recently about the massive changes sweeping over the world economic structure: the loss of manufacturing jobs from the Western World to low-wage nations, and the corresponding growth of the service economy in North America, Western Europe, and Japan. Within these broad trends are many smaller, contributing factors. For example, the service economy includes everything from low-wage, low-skill jobs in fast-food outlets to high-income, high-technology positions in the telecommunications and software industries. Despite the recent implosion of the "dot.com" bubble of the late 1990s, the IT, telecommunications, entertainment, and related fields are still recruiting the colleges heavily and are offering those with advanced degrees in science and engineering very attractive compensation packages. For the foreseeable future, recent college graduates will find employers in these areas to be more exciting, attractive, and lucrative places to work than "old economy" employers. Despite this high demand, the number of U.S. citizens graduating with advanced degrees in science and engineering has been declining for a number of years. These trends will be addressed in more detail in the Discussion section.

Previous Attempts at Reform

As noted, three of the most significant studies of the DoD laboratories and centers took place in the 1980s. They were the Perry Report, Packard Commission Report, and the 1987 DSB Report on Technology Base management in the DoD. This latter study, more than any other, triggered a series of formal efforts aimed at addressing such long-standing laboratory/center problems as the difficulty of attracting and retaining high-quality S&Es, legislative and regulatory barriers, and lack of authority for laboratory managers, often referred to as Technical Director (TD) authority.

The 1987 DSB task force offered its view that, "*This nation has long been well served by defense laboratories* [whose] *contributions have resulted largely from the quality of the scientists and engineers at these laboratories, together with the leadership, resources, and organizations supporting them*." It also concluded that, "*the quality of the laboratories and their technical leadership are of supreme importance to Department of Defense*." To improve this quality, the task force recommended a Laboratory Demonstration Program (LDP).

The Civil Service Reform Act (CSRA) of 1978 (Section 4703, PL 95-454) had authorized the OPM to approve a limited number of demonstration programs to test improved personnel management procedures in Government. Two Navy RDT&E activities were first in line: the Naval Weapons Center (NWC) in China Lake, California (now part of the Naval Air Warfare Center (NAWC)) and the Naval Ocean Systems Center (NOSC) in San Diego, California (now the Space and Naval Warfare (SPAWAR) Systems Center (SSC), San Diego). Within about a year, the two activities were experimenting with pay banding and a number of then-radical procedures that promised to simplify human resources (HR) administration and improve the productivity of the workforce. These became widely known as the "China Lake" demos. The 1987 DSB report said this about them:

"The Demonstration Program contained six elements which are important to improvement of the quality of personnel in laboratories:

- *A simplified classification system which allows optimal development and use of scientists and engineers and which minimizes the personnel system process.*
- *A simplified and improved performance evaluation system.*
- *A performance-based pay system, allowing laboratory management to reward excellent performance.*
- *Provision for starting salaries for new professional scientists and engineers that are competitive with those of the private sector.*
- *Performance-based retention in time of a reduction in force.*
- *Rewards for bench-type S&Es (non-management) for technical contribution rather than management."*

The 1983 Packard report and the 1987 DSB study both acknowledged the early successes attributed to the China Lake demos and recommended that they be expanded and enhanced in order to attract and retain the highest quality personnel in Government. The 1987 DSB study specifically recommended:

"USD(A) [Undersecretary of Defense for Acquisition] should take immediate positive action to expand the NOSC/NWC (China Lake) personnel experiment to all DoD laboratories for all scientists and engineers (S&Es)."

"USD(A) should direct that the individual Services establish a clear line of responsibility, authority, and accountability to each laboratory/technical director in charge of the technical program for program content and execution, for laboratory personnel policies, and for budget formulation and execution. Further, the group recommends that the Service Program Executive Officer appoint these laboratory/technical directors for 5-year appointments, renewable upon annual review and with provisions for removal."

"USD(A) direct each Service to create one demonstration laboratory project: Select at least one laboratory, representative in size and function of that Service's laboratory system, and alter its management and organization as to:

- *Attract and retain highest quality staff.*
- *Improve contracting effectiveness.*
- *Improve personnel management.*
- *Provide local laboratory management authority and accountability."*

The Congress picked up on this idea and, as part of its FY 90 Defense authorization process, the Senate Armed Services Committee directed the Department to establish such a program, including appropriate requests to OPM for exceptions to applicable personnel regulations, for selected laboratories, and to evaluate their operations under a different overall management system.[13,14]

[13] See Senate Bill 1352 and Senate Report S. 101-81.

The Laboratory Demonstration Program

In response, on 20 November 1989, Deputy Secretary of Defense (DEPSECDEF) Donald Atwood issued three separate memos to the Services, the OSD General Counsel, the USD(A), and the Assistant Secretary of Defense (Force Management and Personnel) (ASD(FM&P)), directing a series of complementary actions. Each Service was directed to select at least one "demonstration laboratory" for participation in the LDP. These laboratories were to focus on certain areas: TD authority and use of funds, recruiting/retaining personnel, facilities, and procurement. In formally establishing this pilot-oriented effort, Secretary Atwood noted that, "*Recent studies conducted by the Defense Science Board and validated by the DDR&E Interagency Task Force have shown that the productivity and effectiveness of DoD laboratories can be significantly improved by implementing specific changes in procedures involving personnel management, research-related contracting, facilities refurbishment, and management authority of technical directors.*"

The LDP envisioned that participating laboratories could effect these changes by obtaining relief from the legislative-, regulatory-, and Service-imposed barriers that hindered their efficiency. The OSD staff offices were directed to assist the Services and the demo laboratories in obtaining the necessary legislative and regulatory relief. Therefore, in accordance with the DSB recommendations, the DEPSECDEF's memo directed that action be taken to implement reforms in four broad areas:[15]

- **Laboratory Management**
  - Exercise greater control over directed organizations.
  - Model the authority of directors on the separate "profit center" concept of the private sector.
  - Provide discretionary research funds that are no less than five percent of the gross project costs of the laboratories.

- **Contracting/Procurement**
  - Reduce average procurement times for low-business-risk research and development procurement.
  - Remove constraints beyond the requirements of law.

- **Personnel Management**
  - Increase the acquisition and retention of highly qualified scientists and engineers.
  - Complement Government S&Es with term appointments of retired distinguished senior researchers from industry and academia.

- **Facilities Modernization**
  - Modernize research and development facilities on a 50-year replacement cycle and at an investment rate that is at least two percent of the replacement value.

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[14] Davey, Michael E., Congressional Research Service, "Defense Laboratories: Proposals for Closure and Consolidation." 24 January 1991.
[15] Defense Management Review Laboratory Demonstration Program, Annual Report January 1993.

To oversee the LDP effort, an oversight Working Group was established, along with seven sub-groups covering such areas as: Implementation, Management, Personnel, Contracting, and Facilities. Overall direction of the effort was vested in the Office of the DDR&E. The LDP was formally initiated in May 1990. The deal seemed too good to miss for the Army and Navy: of the total of 29 laboratories/centers participating, 18 were from the Army and nine were from the Navy. Only two Air Force labs were initially identified as LDP participants.

During the next three years, the Services and an elaborate LDP management structure expended significant effort attempting to implement the program initiatives. Many barriers to efficiency were identified, and recommendations proposed.[16] Each of the Services submitted detailed implementation plans to DDR&E in late 1990. For example, the Navy LDP implementation plan identified 62 specific reforms requiring formal action.

In the personnel management area, the laboratories and centers sought authority to automate position classification, develop qualification standards for S&E positions, directly hire personnel, designate three percent of all S&E positions as "supergrades," set salary rates, establish pay-banding, approve performance-award amounts consistent with the activity's budget, approve recruitment and retention bonuses, pay for advanced degrees, repay student loans, eliminate time-in-grade requirements for promotion, expand assignments under the IPA, and approve non-career appointments for retired distinguished senior researchers.

The laboratories and centers also pursued the use of automated position classification systems. Their use was found to enhance morale and reduce the time spent in the classification process. OPM granted authority to directly hire PhDs at the GS-12 level, but this authority was later withdrawn. The Federal Employees Pay Comparability Act (FEPCA) of 1990 established a number of new personnel authorities Government-wide (such as recruitment and retention bonuses) sought by the laboratories and centers. The Defense Acquisition Workforce Improvement Act (DAWIA) of 1991 provided authority to pay for degrees as well as the authority to repay student loans. As beneficial as these authorities were, very few of them resulted from the LDP, and most had to await the issuance of OPM and DoD implementing regulations, some of which took several years.

Furthermore, most of the personnel-related authorities desired by the laboratories and centers under the LDP (such as pay banding) required the formal approval of OPM under the provisions of the CSRA of 1978. Despite lengthy discussions, OPM remained unwilling to utilize its CSRA authority to establish any additional personnel demonstrations for Defense laboratories under Title 5. OPM did not want duplication of features tested in "China Lake" or other demos, but did want features that could be applied Government-wide if successful. OPM insisted on cost neutrality, and wanted extensive justification for why any variation from Title 5 was needed for the laboratories.

As anticipated, the most important LDP initiatives required significant regulatory (e.g., OPM) or legislative relief. Unfortunately, nearly all encountered significant resistance at all organizational levels within the Department. As a result, by the spring of 1992, the lack of progress was causing enthusiasm for the LDP to wane among the participating laboratories and centers. In June 1992,

[16] *Ibid*.

the LDP management structure was reorganized in an attempt to reinvigorate the effort, and a LDP Executive Panel was formally chartered. Even so, little progress resulted.

As previously noted, there can be a number of reasons for a lack of meaningful reform to a complex bureaucratic system. In the case of the LDP, many of its initiatives conflicted with ongoing DoD and/or Service efforts to improve efficiency, especially those being carried out as part of the Defense Management Review (DMR). The DMR was conducted in 1988 and 1989 at the direction of then-President George H. W. Bush, and produced a series of DMR Decisions (DMRDs). Many of these focused on consolidating similar functions and eliminating duplication at the Service laboratories. One, DMRD 922, actually directed a study of laboratory consolidation.

Other DMRDs directed that such support functions as public works, finance and accounting, and human resources be removed from the control of local commands, consolidated at either the Service or the DoD level, and (in some cases) relocated to remote locations. While these consolidation actions were taken in the name of creating efficiencies, they clearly conflicted with the following DEPSECDEF LDP directive:

"Provide Laboratory Technical Directors greater authority over the organizations they direct. Their authority should be modeled on the separate "profit center" concept of the private sector. To accomplish this, the following, at a minimum, are to be implemented by the Services:

- *Support-function personnel (Personnel, Procurement, General Counsel, etc.) are to be co-located at the laboratory and under the direct control of the director."*

Within a year of the LDP's formal implementation, it was clear that in every case where there was a conflict between the LPD and a DMRD, the DMRD would be given preference over the LDP initiative.

In October 1992, DDR&E Victor Reis presented a briefing to DEPSECDEF Atwood to "Identify/recommend options for configuring the DoD science and technology enterprise (leadership, management, execution) - in the post-Cold War era". One of the slides in this presentation was entitled *Laboratory Quality Improvements,* and is reproduced in Figure 4 below. One of the points specifically called attention to the conflict between the goals of the LDP and the DMRDs that were continuing to be issued.

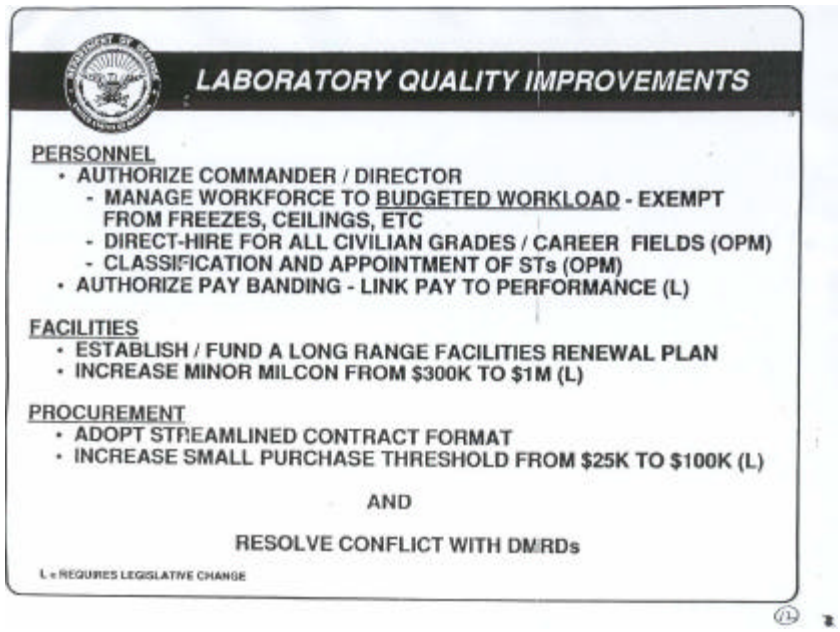

Figure 4: Slide #12 from 1 Oct 1992 Atwood Brief

The Laboratory Quality Improvement Program

DEPSECDEF Atwood endorsed the DDR&E proposal to reinvigorate the LDP and resolve the conflicts with the DMRDs. The three Service Acquisition Executives (SAEs) committed to an intensive joint effort to get the program back on track. In response, a variety of plans, policy memos and other documentation were drafted and sent up the chain of command for approval. The three SAEs met in early 1993 and reached consensus on a plan of action, using the title Laboratory Quality Improvements from the approved slide. This initiative was subsequently chartered as the Laboratory Quality Improvement Program (LQIP), and essentially succeeded the LDP. A new series of panels and sub-panels were established to execute LQIP's charter. Unfortunately, the policy memos that would have given real clout to the LQIP met resistance in some parts of OSD and were never signed.

At about the same time, the National Performance Review (NPR) was getting off the ground. As part of the Clinton Administration's initiative to "reinvent Government," a Defense Performance Review (DPR) office was established in the Pentagon to oversee the Department's "reinvention laboratory" efforts. Soon after, the DDR&E requested the DPR office to designate the LQIP as a reinvention laboratory under the aegis of the NPR. This request was approved in March 1994, and authorized the laboratories and centers to request waivers of Service and OSD policies and regulations in support of DoD's "Installations 2000" vision, specifically: "Installation commanders empowered with the responsibility, authority, flexibility, and resources to make the requisite decisions based on what is best for client tenants and their respective missions." Based on nominations from the Services, DDR&E initially included one Defense, two Navy, four Army, and four Air Force laboratories in the program. Ultimately, the Army extended its participation to all 16 of its R&D laboratories and centers.

One of the basic tenets of the NPR was the identification and elimination of barriers to efficiency, either through legislative change or by waiving burdensome and unnecessary regulations. In fact, during the early days of the DPR, the SECDEF required the senior leadership of the Department to take action on all waiver requests within 30 days or see the waiver take effect automatically. Disapprovals of waiver requests could only be based on statues or national security considerations.

Numerous reforms were attempted under the new LQIP/NPR umbrella. For example, in August and September 1995, the DDR&E requested five waivers from the Civilian Personnel Policy office of OSD: (1) the establishment of a definition of a high grade in a pay-band system, (2) redefinition of the term, "Full Term Equivalent" (FTE), (3) removal of high grade controls, (4) prohibition of hiring freezes, and (5) exemption from the Priority Placement Program (PPP) for internal placements. The ASD(FMP) declined to approve them and placed a 60-day hold on a decision, pending negotiations to resolve differences. Ten months of difficult negotiations between (1) DDR&E and the Services (acting for the LQIP) and (2) ASD(FMP), OMB, and OPM (as stake-holders for the existing system) followed. Finally, in June 1996, the DEPSECDEF approved a negotiated settlement covering: (1) a definition of high grades in pay-banding systems; (2) authorization to exceed FTE authorizations by two percent on a temporary basis to cover IPA assignees, experts and consultants, students, and faculty working at LQIP laboratories and centers; (3) a nine-month grace period to complete staffing actions at LQIP laboratories and centers after the imposition of a hiring freeze, and (4) a process for resolving qualification determinations under the PPP. Although these presented only marginal changes to the system, they were quite simply the best deal that could be gotten. In the end, they provided little benefit to the LQIP laboratories and centers.

In summary, in the area of civilian personnel administration, the LQIP mirrored the LDP, and yielded very few positive results.

Scorecard After a Decade of LDP and LQIP

As noted above, the 1987 DSB study and the 1989 DEPSECDEF directive identified four areas for reform. Based on the record, a reasonable summary of the scorecard for the LDP and LQIP in achieving their objectives is as follows:

- **Laboratory Management:**
  No progress on granting greater authority to laboratory directors. In fact, many support functions previously reporting to laboratory management were removed from laboratories and consolidated into outside organizations.

- **Contracting/Procurement**:
  The laboratories and centers benefited from DoD-wide acquisition reform efforts and the associated streamlining of procurement regulations that became effective during the 1990s. However, only slight gains were made in this area as a result of either the LDP or LQIP.

- **Personnel Management:**
  Consolidation of HR functions removed some local support from laboratories and further slowed an already slow process. Essentially no progress made in simplifying DoD or OPM

regulations and procedures, except as authorized by new legislation initiated by Congress (see next section).

- **Facilities Modernization**
  New legislation (described in next section) raised thresholds for minor construction projects. No other progress.

One important lesson from this experience is that incremental approaches, such as waivers and specific targeted reforms, offer any who oppose change the time and opportunity to martial their forces. Moreover, it is difficult to sustain such efforts over a period of time that can exceed the tenure of the top officials who originally championed the efforts.

Legislative Successes

Although the LDP and LQIP made only marginal and very modest progress in breaking down the regulatory barriers erected by such organizations as OPM, OSD and the Services, they did have more luck on Capitol Hill. Both the LDP and LQIP included as major thrusts the development of new legislation to overcome the kind of statutory hurdles identified by the various studies of the laboratories. Although they were unsuccessful in most cases, in two areas relief was granted by Congress.

Minor Construction

The congressional Military Construction (MILCON) process governs construction of new facilities by DoD (refurbishment of existing facilities is executed in accordance with different procedures). In essence, the military construction system works as follows:

- Major MILCON - Funds for new structures above a certain dollar threshold (currently $1.5M for most facilities) must be specifically approved and appropriated for each project by Congress.
- Unspecified Minor MILCON - Projects costing more than a certain threshold (currently $750K for most facilities) cannot be executed without the specific approval of SECDEF and after Congress has been notified. Funds for such projects are normally provided from an account appropriated for this purpose by Congress.
- Minor Construction - Projects costing less than the Unspecified Minor MILCON threshold can by constructed without approval of Congress, and can be funded by an activity's own funds.

Major MILCON funds are highly prized on the Hill, and often receive intense Congressional scrutiny. In addition, construction projects at the laboratories and centers often do not compete well for such funds within the Services and OSD against those requested by operational commands, e.g., facilities associated with military quality of life. As a result, many of the laboratories and centers continue to make do with many buildings that are old, expensive to maintain, and not conductive to state-of-the-art research. This subject is discussed in more detail in the Findings section below.

The LDP drafted legislative language to increase the above thresholds almost immediately after being established in 1990. After five years of trying to obtain consideration, the bill was finally

approved by OSD and passed by Congress. Section 2892 of the FY 96 NDAA raised both the Major MILCON and Unspecified Minor MILCON limits for DoD-owned and -operated laboratories and T&E centers. The Major MILCON limit was increased from $1.5M to $3M and the Unspecified Minor MILCON threshold from $500K (the limit at the time, now $750K) to $1.0M. Although no new funds were provided, this change in the law permitted the laboratories and centers to use non-MILCON funds to construct new facilities costing up to $1M. Originally limited to a three year (FY 96 - 98) test period, the authority was extended for another five years by Section 2871 of the FY 99 NDAA. It is now scheduled to expire in FY 03; specific legislative authority will be required to extend it beyond then.

Personnel Demonstration Projects

As noted above, the 1987 DSB study had recommended expansion of the China Lake demos to all laboratories and centers. Such an expansion was not possible under the 1978 Civil Service Reform Act, so new legislative authority was required. The LDP and LQIP devoted several years to socializing this proposal within the Pentagon and OPM, but were never able to get a draft bill approved for submission to Congress. Eventually, Congress itself took action, citing the DSB and other studies for justification. Section 342 of the FY 95 NDAA authorized the SECDEF, with approval of OPM, to carry our personnel demonstration projects generally similar to the China Lake project at DoD laboratories designated by SECDEF as S&T reinvention laboratories. This authority has been the only meaningful new set of HR tools to become available to the DoD technical community in decades. Even so, many of the most innovative reforms proposed by the laboratories and centers were regarded as too radical and were not approved. Others were excluded on the grounds they would not allow the demonstrations to be implemented in a cost-neutral way. Appendix F briefly describes examples of reforms proposed by the NRL, one of the S&T demonstration laboratories, that were not approved. Although these are Navy examples, they typify the kinds of relief unsuccessfully sought by the demonstration laboratories and centers in the other two Services.

With respect to the current implementations of the Section 342 personnel demonstration authority, it should be noted that different features have been adopted by the various participating DoD components, though many features are common to all. Interestingly, the administration of the Section 342 personnel demos is managed by the LQIP Personnel Subgroup, the last remaining active vestige of the LQIP.

The Impact of the Lack of Reform

Studies focused on the problems confronting the DoD laboratories have continued to be carried out throughout the 1990s, with 11 by the DSB alone since 1990. Not surprisingly, the most recent ones have noted the lack of any significant action on previous recommendations, and have therefore assumed *a priori* that bureaucratic inertia will always prevent meaningful reform of the Civil Service system. As a result, many of the most recent DSB studies have recommended hiring private sector staff for the laboratories, or even converting them to alternative governance systems such as GOCO. This Panel believes that such approaches would be extremely difficult to execute and/or administer, and would still not solve the underlying problems confronting the laboratories.

A number of the laboratory studies in the 1970s and 1980s predicted that the quality of the laboratory staffs and productivity would decline if no action were taken to improve the competitiveness of these organizations. Several of the most recent studies have asserted that, given the lack of any action on earlier recommendations, this decline is well under way. Such an assertion is very difficult to prove (or disprove), as fundamental research work often does not produce a deployable product for many years. And though there are a number of generally used measures of research staff quality (papers, patents, paper and patent citations, honorary memberships and fellow designations in scholarly societies, awards), these often lag the most productive period in a career by many years.

Prompted by both the DSB and Congress, OSD is currently evaluating various means to objectively measure both the quality and relevance of the R&D work performed by the DoD laboratories and centers. Such an effort is well beyond the charter of this study, so the subject will not be addressed further herein except to note that the DSB has asserted in several recent reports that they believe the quality of many of the DoD labs has begun to decline.

5. DISCUSSION AND FINDINGS

Laboratories Remain Essential and Critical

Over the past 40 years, many authoritative statements regarding the importance of maintaining an in-house laboratory capability in the DoD have been made (Steelman, 1947, President's Science Advisory Committee, 1958; Bell, 1962; Sheingold, 1966; Federal Coordinating Council for Science, Engineering and Technology, 1979; DDR&E, 1980; and Government Accounting Office, 1981.)[17]

While these statements often reflected different emphases, they all endorsed an enduring need for such laboratories. For example, in October 1961, during the height of the Cold War, then-SECDEF Robert McNamara declared: "*in-house laboratories shall be used as the primary means of carrying out Defense Department Research and Development Programs*."[18] Some 15 years later, John Allen, then Deputy Director of Defense Research and Engineering (Research and Advanced Technology), commented in a Blue Ribbon panel study that although a lot of innovation in the Department's technology base program comes from contractors,[19]

> "*No way has been found to preserve the combination of current technical expertise and long-term corporate memory other than setting up an organization wherein individuals*

[17] President's Scientific Research Board, 1947: "Science and Public Policy," (Steelman Report); President's Science Advisory Committee: "Strengthening American Science," 1958; Bureau of the Budget: "Report to the President on Government Contracting for Research and Development, 1962 (Bell Report); Office of the Director of Defense Research and Engineering: "Department of Defense In-House Laboratories," 1966 (Sheingold Report); Federal Coordinating Council for Science, Engineering and Technology report: "Application of OMB Circular A-76 to R&D: An R&D Management Approach," 31 Oct 1979; Under Secretary of Defense (Research and Engineering) report: "Required Capabilities for DoD RDT&E," 1 Oct 1980; Government Accounting Office: "The State of Basic Research in the DoD Laboratories," 1981.

[18] Secretary of Defense Memorandum, "In-House Laboratories" (14 October 1961).

[19] John Allen, Rodney Grantham, and Donald Nichols, "The Department of Defense Laboratory Utilization Study," 28 April 1975.

can maintain a lasting and close association with their Service while staying involved in technology, in short, an in-house laboratory."

In May of 1994, President Clinton requested the National Science and Technology Council (NSTC) to perform a review of Federal Laboratories, including those operated by the DoD. The Council's report, completed on 15 May 1995, stated:[20]

> "*The fundamental responsibility for DoD laboratories is to conduct science and technology programs in support of national security…the overriding mission of the DoD laboratories is national security. Although there are few if any technical constraints to other performers (industrial laboratories, universities) conducting R&D for the military—indeed, DoD outsources most of its R&D—there are compelling arguments for maintaining a quality DoD laboratory system. DoD laboratories are best able to translate between technological opportunities and the warfighters' needs, integrate technologies across life cycles and generations of equipment, respond rapidly to DoD needs, provide special facilities, and offer the necessary technical support to the services to make them smart buyers and users of technology.*"

This statement touches on a number of the functions DoD laboratories have performed over the years. The congressionally-mandated Federal Advisory Commission on Consolidation of Defense Research Laboratories (referred to as the "Adoloph Commission" after its chairman Charles "Pete" Adolph, who was then acting DDR&E) articulated ten such functions: [21]

- Infuse the art of the possible into military planning.
- Act as principal agents in maintaining the technology base.
- Avoid technological surprise and ensure technological innovation.
- Support the acquisition process.
- Provide special-purpose facilities not practical for the private sector.
- Respond rapidly in time of urgent need or national crisis.
- Be a constructive adviser for Department directions and programs based on technical expertise.
- Support the user in the application of emerging technology and introduction of new systems.
- Translate user needs into technology requirements for industry.
- Serve as a science and technology training ground for civilian and military acquisition personnel.

The Evolving Laboratory Environment

Since the end of the Cold War, when the Adolph Commission articulated these functions, the laboratories have undergone a prolonged period of realignment, closure, personnel downsizing,

[20] Executive Office of the President, Office of Science and Technology Policy. "Interagency Federal Laboratory Review Final Report," May 15, 1995.

[21] Federal Advisory Commission on Consolidation and Conversion of Defense Research and Development Laboratories, Report to the Secretary of Defense, September 1991. The Commission was established by Public Law 101-510 to study the DoD laboratories and provide recommendations to the Secretary of Defense on the feasibility and desirability of various means to improve the operation of the DoD laboratories.

and other changes. There have also been significant changes in the way DoD acquires and supports its war-fighting capability, for example as a result of acquisition reform. Such changes in the defense environment raise questions as to what functions the laboratories should play now and in the future. As an example, acquisition reform procedures have shifted the emphasis away from detailed "military specifications" (MILSPECS) toward more generally stated "performance specifications." Consequently, industry now plays a much greater part in deciding how to design and manufacture weapons and other war-fighting systems. Concomitantly, this has considerably reduced the laboratory function of translating user (warfighter) needs into technology requirements (MILSPECS) for industry to follow. Similarly, the role of the laboratories in maintaining the defense technology base has been affected by trends such as the growing role of the private commercial sector in R&D, and the globalization of technology.

Private Sector Reluctance to Invest in High-Risk, Low-Profit S&T

It has been seen that the Service corporate research laboratories largely perform work characterized as S&T. This is generally where new technologies and their potential military application are explored and developed, often over long periods of time. Because of the long time scales involved with performing such work, especially in basic and applied research, and the uncertainty of the outcomes, the commercial sector generally views investment in S&T both as high-risk and unlikely to yield short-term profits. Industry has not been enthusiastic to invest in areas that are primarily or solely of interest only to the military, e.g. anti-submarine warfare, electronic warfare, stealth technology, high-G electronics, counter-mine systems, etc., because of high risk, low quantities and uncertainty regarding return on investment.

It is also clear that the academic community is both unable and unwilling to completely fill the void created by the unwillingness of the commercial sector to invest in military-related S&T. There are several reasons for this. For one, universities remain reluctant to participate more extensively in defense research because of classification concerns that may limit or preclude publishing and peer recognition. This worry has been heightened by a number of post-9/11 moves by the DoD to limit open dissemination of defense-related information. For another, much of the research of today requires significant investments in specialized laboratories, equipment, and other infrastructure necessary to support it. In an era of increasing budget austerity, universities may be unwilling to make such investments in support of defense projects.

At the same time, many of the revolutionary, high-tech, systems used in the Balkans and Afghanistan are products of DoD S&T investments of the 1970s and 80s. The record shows many of these breakthrough technologies resulted from long-term investments in military-specific work in DoD research laboratories. Examples include the GPS, the thermobaric bomb used against the caves of Afghanistan, and various types of sensors, armor, and submarine materials to name but a few.

Evidence that the commercial sector is not anxious to invest in work that is high-risk, or which may not offer a short-term profit return, is reflected by several trends. These trends include a growing number of companies that no longer maintain in-house research laboratories, and a decline in the levels of company-funded basic research. These trends are discussed in detail in the following sections.

Cutbacks in Company-Funded Central Research

One of the conclusions reached by the DSB in the report, *Technology Capabilities of Non-DoD Providers*, is that global investments in research are soaring, and, therefore, DoD should utilize commercial technology when non-defense goods are involved, while concentrating in-house laboratory resources on militarily unique technologies and systems. However, even though the commercial sector seems to be investing more in "R&D," it is increasingly cautious about putting money into basic research and supporting its own corporate research laboratories. For example, a recent report by the Council on Competitiveness comments:

> "*U.S. R&D investment, as a share of national wealth, is lower today than it was in 1985. Although the dollar amount of investment in R&D grew from $115 billion in 1985 to over $200 billion in 1998, the increase was overwhelmingly due to growing investments by industry. The bulk of industry's investment, however, was properly targeted on the development of new products, processes and services, not on basic discovery*."[22]

Aversion to risk and a desire by industry to reap near-term profits are not the only factors that inhibit private sector investment in fundamental research. Another factor driving such decisions is that companies have been unable to develop reliable metrics for determining their return on investment in such research. The problem is simple: measuring laboratory productivity is very complex. Because of the uncertainties associated with the measurement of return on investment in commercial R&D, many corporate executives and business unit leaders mistrust R&D productivity measures, and this has led corporations "*to look elsewhere for competitive advantage—for example, from marketing, acquisition, capital investment, and so on*."[23] This uncertainty has also led many companies to reduce or eliminate altogether their investments in long-term research. Other companies have reacted by cutting back on "central" or "corporate" sponsorship of R&D units, forcing them to rely instead on business unit funding for support. Business unit-funded R&D tends to be of a short-term nature, and focused on improvement of existing products or on processes for manufacturing those products.

Where is Industry Putting Its R&D Money?

At first glance, available data suggest that industry is the dominant contributor to all U.S. national research, while the Federal Government's contribution has been essentially flat since the mid-1980s. This also appears to be the conclusion suggested by Figure 5, which is based on data collected by the National Science Foundation (NSF), which in accordance with its 1950 mandate to render "indicators" to the President in each even numbered year, collects these data. The specific data displayed are from *Science and Engineering Indicators—2000*, the most recent edition.[24] The numbers for 1999 were: all sources ($247 billion), industry ($169 billion), Federal Government ($66 billion), and all others ($12 billion).

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[22] Porter, Michael E. and van Opstal, Debra, "U.S. Competitiveness 2001: Strengths, Vulnerabilities and Long-Term Priorities," The Council on Competitiveness, January 2001. The report can be found at: http://www.compete.org/pdf/competitiveness2001.pdf

[23] Fusfeld, Alan R., "Assessing the Value of Your Technology," *Research Technology Management*, September-October 1998.

[24] The year 2000 results are found at: http://www.nsf.gov/sbe/srs/stats.htm, and the numbers displayed in Figure 6 are from the EXCEL file http://www.nsf.gov/sbe/srs/nsf00306/tables/tb7.xls. The letters (…) displayed in the chart legend identify the specific column in this 175-column table that is plotted.

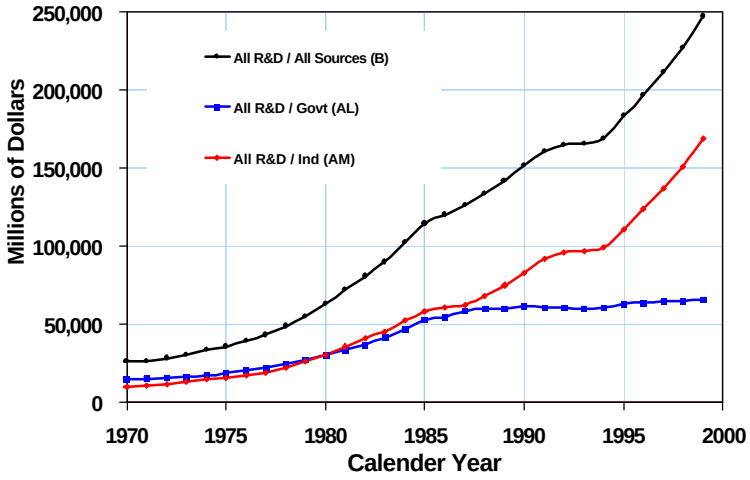

Figure 5: Government and Industry R&D Spending

Figure 6 displays the data by category of "funder," "performer," and by categories of research—Basic, Applied, and Development.

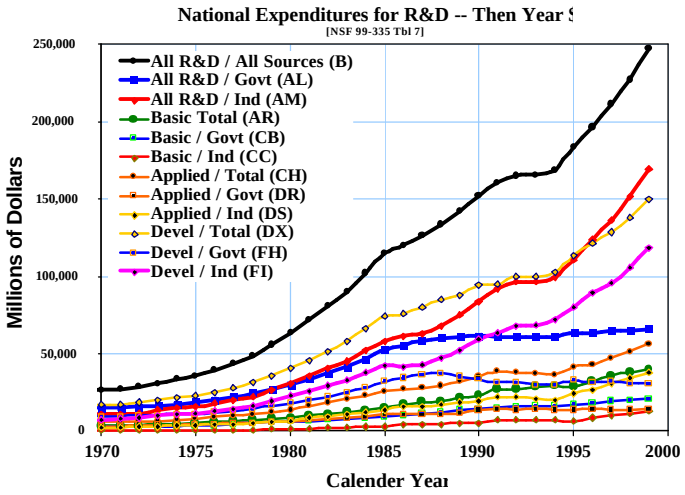

Figure 6: R&D Spending by Source, Category, Performer

Figure 7 shows the bottom 20 percent of the big picture shown in the previous figure. It includes the contributions made by the Federal Government and industry in the basic and applied research categories. It should be noted that these data are collected by means of a survey and, therefore, the respondents' perception of the nature of "research" is subjective, and may not entirely accord

with the RDT&E Budget Activities 6.1 (basic research) and 6.2 (applied research) definitions used by DoD.

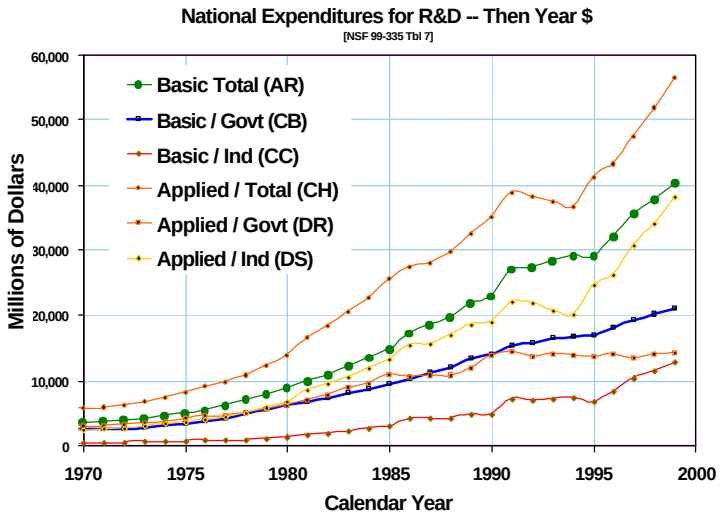

Figure 7: Government and Industry Spending on Basic and Applied Research

From this figure, it can be seen that the Federal Government still leads industry in spending on "basic" research, spending about twice as much as industry. However, industry spends more for applied research than the Government does. Figure 7 also illustrates that the dominant contribution to the increase in industrially funded "research" is actually in the "development" category. As an aside, it should be remembered that, in trying to trace any source of funding, once the money is "spent" by any "sector" e.g. Federal Government, industry, academia, it is often difficult to trace it back to its true source. For example, Government money given to an industry that is almost entirely dependent on the Federal Government for its income, and then spent by the industry on research (or reported on the NSF survey) still came from the Government. Or, Federal dollars received by an in-house laboratory are often contracted out to a university or company.

Adequacy of Commercial R&D for Long-Term Defense Technology Needs

From the foregoing, it is clear that industry has certainly expanded its investments in R&D over the last several years. But, as the NSF data indicate, this growth is primarily in the area of product development, a trend confirmed by data found in the annual surveys by the Industrial Research Institute (IRI) and the Center for Innovation Management Studies (CIMS) at Lehigh University. The IRI/CIMS data have been collected since 1993, and contain IRI company data for fiscal years 1992 through 1998, the most recent. The survey seeks financial data about the source and allocation of R&D funds at three organizational levels within the responding company: at the firm level, the business-segment level, and the laboratory level. Figure 8, based

on fiscal year 1996 and 1998 survey data, depicts changing patterns of expenditure at the industrial laboratory level.[25]

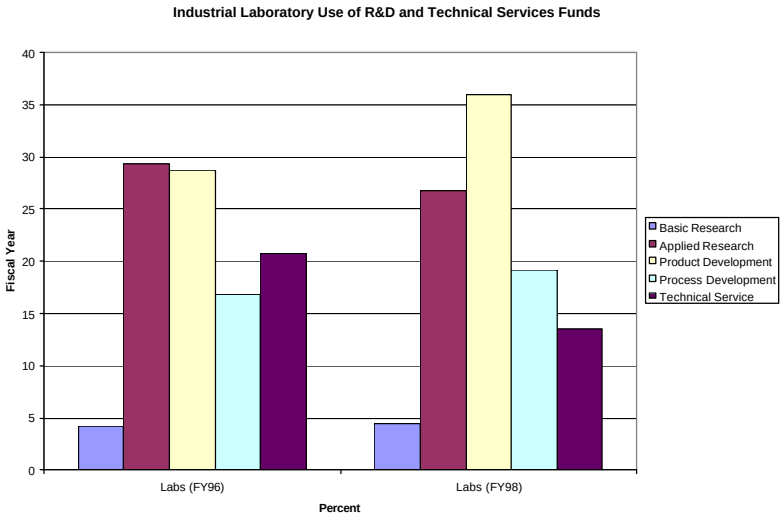

Figure 8: Industrial Laboratory Use of R&D and Technical Services Funds

These laboratory-level data reflect the same trends seen in both the firm and segment level data, and show industrial spending on applied research and technical services are decreasing, while spending on process and product development are increasing. Thus, industry is investing in low-risk, high-profit endeavors whenever it can.

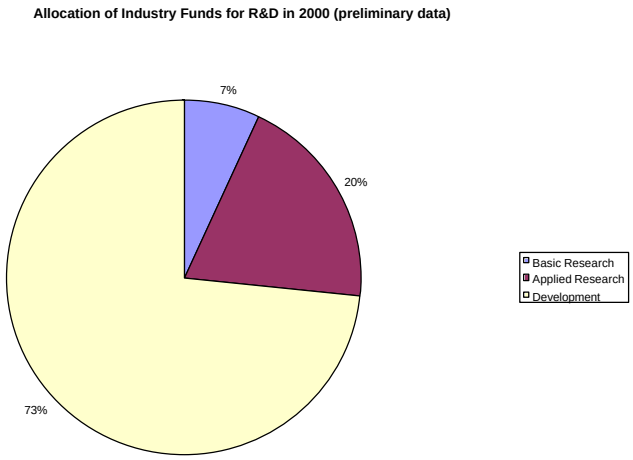

Figure 9: Allocation of Industry R&D Funds in 2000 (preliminary data)

[25] Alden S. Bean, M. Jean Russo and Roger L. Whitely, "Benchmarking Your R&D: Results from IRI/CIMS Annual R&D Survey for FY '96, *Research Technology Management*, January-February 1998; Alden S. Bean, M. Jean Russo and Roger L. Whitely, "Benchmarking Your R&D: Results from IRI/CIMS Annual R&D Survey for FY '98, *Research Technology Management*, January-February 2000.

Figure 9, also based on IRI data, shows that the largest portion of industry's R&D expenditures (73%) is allocated for development activities, such as product prototypes and processes.[26] About 20% is spent on applied research relating to existing or potential lines of business. The remainder, about 7%, is used for directed basic research, without specific commercial objectives.

According to these IRI data, the top 100 industrial R&D spenders account for 66% of industrial R&D funding; the top 10 spenders alone represent almost a quarter (24%) of the total. In terms of spending in billions of current-year dollars, the top 10 investors in 2000 were: Ford ($7.1), General Motors ($6.8), Lucent Technologies ($4.8), IBM ($4.6), DuPont ($3.9), Motorola ($3.5), Intel ($3.5), Microsoft ($3.0), Pfizer ($2.8) and Johnson & Johnson ($2.6). Figure 10 shows changes in industrial R&D spending over the period 1995-2000 for the three categories: basic research, applied research, and development. As can be seen, the greatest growth is in the Development category.

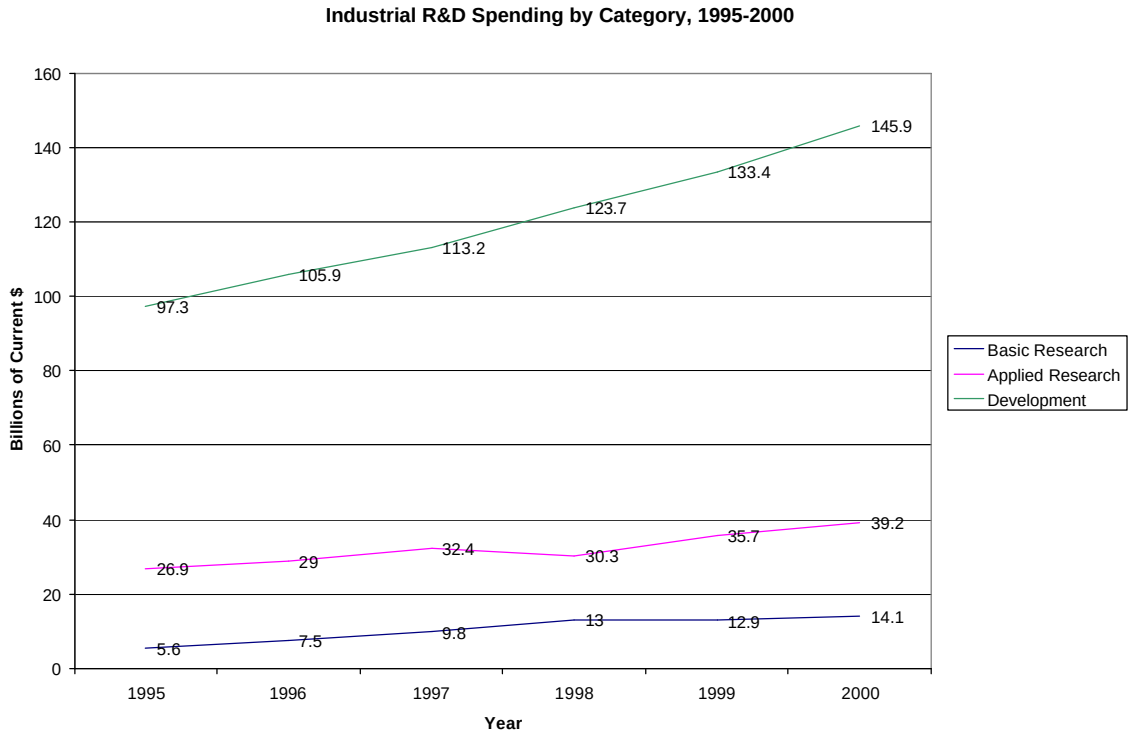

Figure 10: Industrial R&D Spending by Category, 1995-2000

So, while industry has spent more money on R&D in general, it has put most of the investment in improving its product lines and the way they are manufactured. Moreover, some of this increase by industry has come at the expense of investments in applied research and technical services. Industry investments in basic research are more or less steady, but quite small relative to overall industry R&D investments.

[26] Industrial Research Institute, http://www.iriinc.org/web/Publications

According to IRI data, the bulk of industry R&D is spent by firms in the information technology and life sciences fields with eight of the top ten, 19 of the top 25, and 37 of the top 50 leading industry R&D investors in these businesses.[27]

It is also true, as the DSB contends, that DoD's R&D investment is a small percentage of the total global R&D investment. But, to what extent can or should the DoD rely on this global base for future technology needs? In areas like information technology and the biological sciences, the DoD will have to rely on commercial technology for many of its needs. However, with the industry focus largely on incremental improvements to existing products and processes, it is not clear to what extent the DoD can rely on this commercial base for its longer term needs. Some insight into this issue is provided by a study carried out by the Center for Naval Analyses (CNA) for the DON's S&T resource sponsor, aimed at determining whether industry is performing and/or sponsoring basic research that could be useful to the DON.[28]

According to this report, "*the Navy ought not reduce its current level of support for basic research in the hope that it could leverage industry work. If industrial work is kept proprietary or is in areas of no interest to the Navy, it does not represent an opportunity for the Navy to save on its own research. We estimate that the body of industry-funded basic research that is published, of interest to the Navy, and not already known to the Office of Naval Research (ONR) represents only a few million dollars' worth of work, roughly a percent or two of the Navy's basic research budget. As such, it does not present a major opportunity for leveraging or cost saving*." [Emphasis added.]

Importantly, the CNA study found that industry's research spending pattern is more dynamic than that of the other funders, a fact conventionally ascribed to industry's sensitivity to economic conditions, particularly to industry's cost of borrowing money (current rate for 6-month commercial bond minus inflation). In fact, the study shows that "*as a fraction of GDP, industrial spending on basic research (whose benefits normally accrue in the long run) closely tracks this short-term cost*." The study cautions that this "*apparent dependence of industrial basic research funding on short-term fluctuations of the economy may raise questions about industry's ability to pursue basic research projects that are long-term in either or both of two senses: a long period of work is needed [or] there will be a long wait between completion of the research and the Navy's purchase of the product*."

With regard to industry's reluctance to spend on more fundamental research, the study found that "almost uniformly, representatives of the organizations we visited attributed this decline to a new focus in industry on the short-term horizon. Some referred to this as the "MBA syndrome": whereas in the past scientific and technical people were often found among corporations' executives and decision-makers, today there is a preponderance of business-trained people whose emphasis is on the bottom line—to increasing profits and stock values—and on the short-term business horizon. These executives see little value in research, let alone basic research, and are able to prove their point by increasing short–run profits while slashing research funds. The

[27] "Industrial Research Institute's 2nd Annual R&D Leaderboard, *Research Technology Management*, January-February 2001.

[28] "Navy/Industry Basic Research Study," Center for Naval Analyses, CRM 97-40/June 1997.

recent bubble burst and stock market plunge will undoubtedly influence this approach---how is not known.

In light of the foregoing discussion, the Panel believes that, although the functions of the DoD laboratories have evolved, and will continue to do so, they continue to perform functions critical to national defense in support of their individual Service acquisition responsibilities under Title 10 of the United States Code. This section assigns the Service Secretaries the responsibility to provide the military capabilities required by the military chiefs of the armed forces. These responsibilities include developing tactical concepts; managing research and development; acquiring weapons and supporting systems; recruiting, educating, and training personnel, etc. Put differently, the Services are responsible for their respective acquisition processes, and the Service laboratories "are integral components of the Military Departments' acquisition and combat support infrastructure."[29] Therefore, the DoD laboratories are still required to help their parent Services:

- Avoid technological surprise and ensure technological innovation.
- Respond rapidly in time of urgent need or national crisis.
- Act as principal agents in maintaining the defense technology base.
- Serve as an intellectual partner in the national R&D enterprise.
- Infuse the art of the possible into military planning.
- Determine what can and cannot be done from a technical perspective.
- Provide special-purpose facilities not practical or too costly for the private sector to support.
- Act as a constructive advisor for DoD directions and programs based on their technical expertise.
- Support the user (warfighter) in the application of emerging technology, and the introduction of new systems.
- Translate user needs into technology requirements for industry.
- Serve as a science and technology training ground for civilian and military acquisition personnel.

In sum, these laboratories have served the nation well in the past, and will be needed — perhaps more so — to do so in the future.

Characteristics of a World-Class S&T Laboratory

What it takes for a laboratory to be a "world-class" is a subject that has received extensive attention. Those who have studied the subject have compiled extensive lists of characteristics that contribute to such stature, e.g., the list compiled by the 1992 Adolph Commission. These lists typically include the following or similar characteristics:

- World-class S&Es.
- State-of-the-art facilities and equipment.
- Important and challenging work.

[29] Director of Defense Research and Engineering Memorandum for the Assistant to the President for Science and Technology, Subject: Department of Defense Response to NSTC/PRD #1, Presidential Review Directive on an Interagency Review of Federal Laboratories, 24 Feb 1995.

- Adequate and stable sources of funding.
- Clarity of mission.
- Visionary leadership.
- A reasonable level of autonomy.
- A long-term outlook.
- Pride in public service and institutional pride.
- Adequate technical and laboratory support.
- High-quality colleagues.

Of these, the first three — people, facilities, and challenging work — are considered by most who have studied this subject to be essential ingredients. That is, they are the *sine qua non* of excellence. The other characteristics are also important, but not all of them are essential. Several of these characteristics are discussed more fully in the following sections.

Outstanding People: The Key to a "World-Class" Laboratory

First and foremost is the need for a superior technical staff, because an organization remains "world-class" only by hiring and retaining productive, high-quality people, including a few who have exceptional talent. There is no exact figure for just how many exceptional people a laboratory needs to be world class, but there is evidence that suggests the figure is probably around ten percent of the technical workforce for a laboratory whose primary mission is fundamental research. In this regard, Dr. Hans Mark, former DDR&E, remarked: "*The presence of a few individuals of exceptional talent has, to a very large degree, been responsible for the success (and even the existence) of outstanding research and technology development organizations*."[30] Philip Handler, a former president of the National Academy of Sciences, put it this way: "*In the advancement of science, the best is vastly more important than the next best.*"[31] An executive vice president at 3M Corporation commented: "*An outstanding researcher is worth 4 or 5 times more than the average scientist*."[32] Similarly, a strategic review of health and medical research in Australia discussed developing a talented research workforce, emphasizing that:[33]

> "*Building a highly talented research workforce is the key for success in health and medical research—as it is in most professional endeavours. Research generally involves organizational leverage. For example, principal investigators generally work with a number of postdoctoral researchers, postgraduate students and technical staff, and this leverages their time and expertise to focus on the highest value activities.*"
>
> "*Furthermore, scientific output is concentrated amongst relatively few scientists. A 1983 review of publication productivity studies*[34] *concluded that the* ***top 10% to 15% of scientists contribute*** *about half the papers published and that this is consistent across a*

[30] Mark, Hans, "The Management of Research Institutions," NASA SP 481, 1984.
[31] Cited in a speech by the president of the University of Pennsylvania, quoted in, "IAST and the Vagelos Laboratories: The Sign and Symbol of a New Research Agenda," http://www.upenn.edu/almanac/v42/n9/last.html
[32] From a briefing to the NRAC Panel by professor Howard Risher.
[33] "The Virtuous Cycle, Working together for health and medical research," Final Report of the Health and Medical Research Strategic Review, http://www.hmrsr.com
[34] Fox, M.F., "Publication Productivity Amongst Scientists: A Critical Review," *Social Studies of Science*, Vol. 13, No. 2, May, 1983.

range of fields. Work comparing the distribution of citations to the distribution of publications[35] *shows that the inequality in citations is much greater than the inequality in publications. This suggests that fewer than 10% of scientists are responsible for about half of citations in a field. These individuals are in great demand around the world, and health and medical research in Australia must compete with other countries for their talents.*" [emphasis added]

In fact, bibliometric analyses of the scientific literature support the view that most of the innovative ideas of an organization like a laboratory flow from a few highly talented individuals who rely on the technical staff to leverage "*their time and expertise to focus on other high-value activity.*" Regardless of the exact number, there is widespread agreement that for an organization to be "world class", it must have a small cadre of truly outstanding employees, and it must therefore have the flexibility to offer whatever it takes to attract and retain them.

State-of-the-Art Facilities and Scientific Equipment

The Adolph Commission also identified state-of-the-art facilities and equipment as a significant characteristic of a world-class research laboratory. In their report to Congress, members noted that including many specialized laboratory facilities "*appropriate to advancing the leading edge of relevant technologies are necessary to fully exploit the creative potential of scientists and engineers. They include laboratory facilities that are unique and highly specialized to execute the laboratory's substantive and unique mission. New technical facilities must become available at the rate for which technology advancement is desired; there is a direct cause-and-effect relationship.*"

Similarly, the 1987 DSB task force commented, "*R&D depends upon the use of state-of-the-art equipment and facilities. Providing such facilities and equipment is made difficult by rapidly changing technology which results in equipment becoming quickly outmoded and by the increasing cost of renewing such equipment and facilities*."[36] Importantly, this task force noted that "*without very good facilities and equipment, in some areas, even an excellent researcher cannot compete with a mediocre researcher who does have the facilities*."

To do cutting-edge technical work then, a laboratory must have the resources to make continuous and substantial investments in facilities and scientific equipment, and it must have the authority to invest in those resources when and where they are needed. Unfortunately, this is becoming more difficult for the in-house laboratories, because they are inhibited from doing so by a growing tangle of statutes, rules, and regulations.

Construction of most new facilities is subject to the idiosyncrasies in the Military Construction (MILCON) process. Politics, competing priorities, and other factors can delay construction for years. Indeed, many facilities, e.g., general-purpose research buildings, rarely make it through the MILCON process. A 1990 study on improving in-house laboratory facilities found the average age of DoD laboratory buildings was 33 years, compared to 22 years for all Government buildings and 17 for industrial R&D centers. In addition, 55 percent of all DoD R&D facilities

[35] Allison, P.D., Long, J.S., Krauze, T.K., "Cumulative Advantage and Inequality in Science," *American Sociological Review* 47:615-25.
[36] Report of the Defense Science Board 1987 Summer Study on Technology Base Management, December 1987.

were then more than 40 years old, and the replacement cycle for the DoD R&D physical plant was over 100 years compared with 18 years for industrial R&D facilities.[37] According to an internal ONR report called the "*Quiet Crisis,*" the average age of research facilities at the NRL is 49 years, while more than 67 percent are older than 40.[38] Moreover, the physical plant replacement cycle at the NRL is now 175 years. Certainly, the construction carried out through the BRAC process has affected the 1990 figures cited above. For example, when the old Naval Air Development Center (NADC) at Warminister, Pennsylvania closed, its people and programs were shifted to the NAWC, Aircraft Division at the Naval Air Station (NAS), Patuxent River, Maryland. To do this, a vigorous MILCON program was undertaken at the latter site. However, at many other in-house laboratory sites, there have been virtually no R&D MILCON projects for many years.

Without MILCON funding, many in-house laboratories are forced to upgrade old facilities, even though renovation is often less efficient, and much more expensive than new construction.

State-of-the-art equipment is also essential for a first-class laboratory. Again, rules and regulations intended to control spending at more "usual" Government functions tend to hamstring laboratory equipment purchases. The three Services handle equipment purchases in different ways, so the subject will not be explored fully here. However, it is worth noting that Navy Working Capital Fund activities have the most ponderous and bureaucratically burdensome system.

For working-capital-funded laboratories like NRL, equipment or other items costing more than a specified amount (currently $100K) must be budgeted for in advance and funded from its Capital Purchase Program (CPP) budget. Laboratory-funded minor construction and rehabilitation of existing structures must also be funded through the CPP. There are four categories of CPP: minor construction, equipment, automatic data processing equipment, and software. Any CPP item costing $500,000 or more must be specifically approved by both the Navy and OSD Comptrollers. CPP funds are the Laboratory's own money generated through overhead charges on customer orders. NRL does not receive any direct subsidies for equipment purchases.

For NRL to purchase a capital asset, the Laboratory must be issued CPP authority, which is allocated at the start of each fiscal year, based on budget requests established up to two years earlier. Budget exhibits require detailed justification, including economic analyses for major projects. The CPP authority, i.e., approval to spend NRL's CPP funds for capital investments, must be granted by both the Navy and OSD Comptrollers. The CPP authority is subject to statutory limitations, expires after one year, and cannot be reprogrammed between any of the four categories or extended beyond the fiscal year without Navy and/or OSD Comptroller approval.

NRL's CPP authority during the past few years has been $17,300,000, roughly 2% of its total business base. In many years, either the OSD or Navy Comptroller's office attempts to reduce

[37] DoD Defense Management Review, "Report of the Laboratory Demonstration Program Facilities Working Group on the DoD R&D Activity Facilities Modernization Requirements," 4 May 1990.
[38] Lackie, K., Dahlburg, J., DeYoung, D., and Soto, M., "Naval Science & Technology and the "Quiet Crisis," September 2000.

NRL's CPP budget on the grounds that it exceeds those of the average Navy activity or those of the average Navy warfare and systems center. This is "management by arithmetic" — another version of the one-size-fits-all approach to management. When this happens, the Laboratory must then justify the higher level of investment in its own infrastructure or lose the ability to spend its own overhead money. Several past blue-ribbon studies have criticized such practices, and they are one of the issues underlying the oft-repeated recommendation to grant laboratory directors the autonomy and authority to manage their own organizations.

Important and Challenging Work

In the past, the DoD laboratories have sought to offset the pay disadvantage for Government workers by offering high quality S&Es important and challenging work. Such work has long been recognized as a major attraction for talented individuals. For example, as long ago as 1962, the Bell report noted, *"Having significant and challenging work to do is the most important element in establishing a successful research and development organization*."[39] The Bell report, more properly known as the Bureau of the Budget Report to the President on "Government Contracting for Research and Development," was a top-level committee appointed by President Kennedy and chaired by his Budget Director, David Bell, to look at problems in the DoD laboratories. Its membership also included then SECDEF Robert McNamara.

The Adolph Commission and several other studies of the labs also noted that good morale among laboratory staff is based in part on interesting work. The *Quiet Crisis* put it this way: "*One of the strongest attractions offered by the Naval in-house S&T enterprise is the wide variety of interesting, challenging and important work assignments, free from the pressure to introduce a new product every year, which is a pervasive pressure in most industrial laboratories today. This is important because fundamental research often does not produce a mature product or process for 20 years or more*."

Robert Kittredge studied scientific and engineering personnel at the Naval Undersea Warfare Center (NUWC) to find out why some left for private industry.[40] Using a concept called "career anchors," he also examined why some of those who left later returned to the Government. In this context, a career anchor is something that regulates the driving and constraining forces of career decisions. Most of the subjects of the study occupied high-grade positions in the Government, i.e. grades 13 through 15. The results showed that by far the most significant reason for leaving was a combination of making more money coupled with other factors that included pay freezes, lack of promotion potential, frustration with Government bureaucracy, and looking for new and challenging work. Many resented the perceived change from hands-on work to paper shuffling and contract monitoring. Kittredge then found the top two reasons cited for returning to Government work were:

- Lack of real technical (R&D) work in industry, and a desire to get back to advancing the state of technology.

[39] Bureau of the Budget, "Report to the President on Contracting for Research and Development," (Bell Report), 30 Apr 1962.

[40] Kittredge, Robert J., "What Makes Technical Professionals Leave and Then Return?: Career Anchors in a Federal R&D Laboratory." Thesis submitted to the Alfred P. Sloan School in partial fulfillment of the requirements for the Degree of Master of Science in Management, 25 Mar 1988.

- Dissatisfaction with the profit motive/business techniques and practices of industry.

Kittredge noted, "*It is ironic that this theme* [lack of technical work in industry] *was prevalent in 80% of the interview responses. Almost everyone interviewed came to believe that good technical work was very hard to come by in industry. For the vast majority of the returnees, what seemed to be such a good deal turned out to be rather empty and hollow, and unable to fulfill their technical desires.*"

Clearly, challenging work attracts S&Es. Unfortunately, it is becoming increasingly difficult to provide it. One reason is that discretionary money for laboratory directors has declined significantly over recent years. Another factor impeding in-house laboratories' ability to provide challenging technical work is the long-term trend toward outsourcing. This means less work for in-house laboratory staff but, more importantly, it also means these same staff are increasingly saddled with overseeing the work of those performing it. This is precisely the "*contract monitoring and paper shuffling*" Kittredge found to be significant in determining why people left their Government laboratory. Such work does not provide the satisfaction of doing actual hands-on technical work. Indeed, lack of interesting work can act as a disincentive to remain in the Government, making the higher pay in the private sector a more important consideration to those weighing employment decisions.

Adequate and Stable Funding

Funding issues at in-house laboratories have been discussed extensively over the years. Vannevar Bush, for example, in his classic 1945 book *Science, The Endless Frontier*, emphasized the need for continued, intensive Federal support for scientific research.[41]

The Packard Commission also assessed laboratory funding, recommending that Congress authorize funding of R&D on a multiyear basis to provide more stability, noting, *"the direction and performance of Federal laboratories is less than optimal because of serious problems with the continuity of research funding. Supporting high quality research requires stability and a long-range view.*" [42]

One year after the Packard report, a White House Science Council report addressed the Packard panel's recommendations and suggested additional actions for their implementation.[43] This report argued that funding instabilities impede the planning and operation of research programs in Federal laboratories, and also suggested that Congress adopt a biennial budget for Federal laboratories.

In the past, this is one area where in-house laboratories have generally done better than industry in competing for high quality S&Es. Stable levels of funding are especially important to those engaged in fundamental research, where projects can extend for several years before the work is

[41] Bush, Vannevar, Science. The Endless Frontier, July 1945.
[42] White House Science Council, "Report of the White House Science Council. Federal Laboratory Review Panel," May 1983.
[43] White House Science Council, Federal Coordinating Committee on Science and Technology Funding Working Group, "Report on Funding Recommendations," May 1984.

terminated or transitioned. In this regard, the *Quiet Crisis* points out that "*the extraordinary historical productivity of several of America's most innovative and important research laboratories (Bell Telephone, duPont, Xerox, IBM) is often traced to their commitment to a long-term, stable support to researchers and programs with productive pasts and promising futures*."

Lack of long-term support for research in industry is not a new problem, and was a principal subject of a 1988 DSB summer study on the defense industrial and technology base: "*a pattern of inadequate long-term investment by prime and subtier suppliers is a primary cause of the increasing deterioration of the defense industrial and technology base. This inadequate investment can be attributed to pressure on defense industries to provide short-term returns equal to those available from lower risk investments.*"[44] Indeed, the pressure on private sector companies to profit is much greater today than in 1988, at the end of the Cold War. These trends help explain Kittredge's finding that many who left Government laboratory research and later returned did so because "*good technical work was very hard to come by in industry*."

Visionary Leadership

The Packard Commission noted, "*The quality of management is crucial to a laboratory's performance. Federal agencies must insist on highly competent laboratory directors*."[45] The Adolph Commission also identified "*an inspired, empowered, highly qualified leadership committed to technical excellence through support for excellence, creativity, and high-risk/high-payoff initiatives*," as one of the essential elements of a world-class laboratory. The Commission specified several attributes of a good laboratory director:

- High standards of qualification in technical background and technology management experience.
- Commitment to a creative work environment where individual initiative in support of laboratory functions is encouraged and nurtured.
- A long-term management perspective of planning, accomplishment, and resource commitment, because technological breakthroughs can take many years to mature into operational applications.
- Willingness to undertake technology developments recognized as being high risk, and having high payoff potential.

In other words, successful laboratories have leaders with vision, who know how to balance long-range challenges against immediate technology needs, and risk against payoff. Moreover, as noted in the *Quiet Crisis*, such leaders must also direct programs by choosing the areas in which to work, divest work that has become more appropriate for other performers (transition), judge scientific and technical merit, and orchestrate the conditions that foster innovation. Because of the long-term horizon for much scientific and technical effort, continuity of leadership is also

[44] Final Report of the Defense Science Board 1988 Summer Study on "The Defense Industrial and Technology Base," October 1988, Volume I.
[45] Federal Laboratory Review Panel, "Report of the White House Science Council," May 1983.

important. In short, effective leadership is crucial to laboratory success, and in the retention of top quality S&Es.

Reasonable Autonomy

Autonomy is another critical requirement for creative S&T. In fact, in the case of the DON, a desire for a certain degree of autonomy was a major factor that prompted the decision by Congress to place the ONR and the NRL directly under the Secretary of the Navy and apart from the more short-term-focused operational Navy commands headed by the Chief of Naval Operations. Nevertheless, as noted above, such reporting chains do not shield NRL or other WCF activities from one-size-fits-all decision-making by the OSD and Service comptroller and HR machinery.

The ability of the DoD laboratories to offer some scientific autonomy to its S&Es has been a strong asset in recruiting and retaining top technical staff who value the freedom to pursue new ideas. This is analogous to the academic freedom universities use so effectively to attract outstanding teachers and researchers.

Often, laboratory directors rely on various sources of discretionary funding to allow top quality staff members to follow new lines of research. But, along with the rest of the Defense budget, sources of discretionary funding are drying up. This affects the laboratories in two ways. First, it inhibits the ability to pursue new ideas not yet ripe for support by higher categories of funding, e.g., those associated with approved acquisition efforts. Second, it deprives the laboratories of a tool to hire and retain high quality staff. Because of its importance, this point is amplified in the Discussion/Findings section.

Pride in Public Service & Institutional Pride

Recent years have witnessed widespread erosion in the pride of public service. Its impact on the ability of Government to attract and keep excellent employees should not be underestimated, a point recognized in the February 2000 report of the DSB task force on Human Resource Strategy: "*National leaders at every level, need to speak to the American public, on an ongoing basis, about the value of public service—both civilian and military*."

In fact, *Quiet Crisis* drew its name from the 1989 Volcker Commission. Since 1989 there have been many more studies, blue-ribbon panels, and task forces that have considered the erosion of pride of public service, but nothing substantive has been done to improve the image of working for the Government despite much renewed attention to the problem.

For example, in September 1999, a *Government Executive Magazine* article addressed the image of public service noting, *"Because it has become fashionable to denigrate federal service and government jobs often pay less than those in the private sector, the idea of working for the government is a far less attractive option for young college graduates*."[46] Rosslyn Kleeman of the George Washington University's Department of Public Administration had this to say about public service: "*The image does not sit well with my graduate students who would like to go into government, but are concerned about the image.*" And a 1998 study conducted at George

[46] Figura, Susannah Zak, "Young Blood," *Government Executive Magazine,* 1 September 1999.

Washington for the Pew Charitable Trusts and the National Association of Schools of Public Affairs and Administration found that Phi Beta Kappa honor society members generally have unfavorable views of Government careers. Only 21 percent of those surveyed believed Federal service provided good opportunities for personal growth and skill development, and only 21 percent said they believed they would have capable co-workers in a Federal job.

The February 2000 DSB task force worried specifically about the effect of declining pride of public and military service on recruiting and retaining personnel, noting that "*overall, the allure of pubic service has faded*." The task force recommended that the DoD "*should take specific action to promote more understanding of the value of public service in both military and civilian positions. Specifically, the Secretary of Defense should charge the Service Secretaries as a group with the responsibility to develop, execute, and fund an outreach strategy. Outreach programs should be a critical component of the Department's human resources responsibilities*."

Institutional pride is another factor that can affect job decisions. This is closely related to the notion of affiliation, i.e. a sense of belonging to something larger than oneself. Studies have shown that working for a respected organization is an important consideration to almost all employees. This can be enhanced by a leadership that communicates a strong sense of mission, vision that enable the need for affiliation to be met.[47] Having a well-known "brand" name for the institution, e.g. Bell Labs, is an asset in this regard.

Adequate Technical and Laboratory Support

For a laboratory to be truly world-class, its S&Es must be able to leverage a highly responsive support system, e.g. technicians and other support staff. System responsiveness is the key, and cannot be delivered by an overly centralized, highly bureaucratic, support system that considers itself an end, a point noted in the management literature by Peter Drucker:[48]

> "*What people mean by bureaucracy, and rightly condemn, is a management that has come to misconceive of itself as an end and the institution as a means…The hospital does not exist for the sake of the doctors and nurses, but for the patients…the school does not exist for the sake of the teachers, but for the students.*"

The point is that flexibility in managing laboratory support functions is essential. Unfortunately, today, the authority of laboratory directors over their support functions has been greatly eroded as services once under their local control have been turned over to various centrally managed organizations, ostensibly to save money. These services include public works, base operations, finance and accounting, and human resources. This has negatively impacted system responsiveness, and the delivery of services to laboratory employees. For example,

[47] See for example "What Do Employees Really Want? The Perception vs. The Reality," Korn/Ferry International in conjunction with The Center for Effective Organizations, Marshall School of Business, University of Southern California, 2001; "High-Technology @Work™," AON Consulting Workforce Commitment Report 2000; Marshall, Michael L. and Hazell, J. Eric, "Private Sector Downsizing: Implications for DoD," Acquisition Review Quarterly, Spring 2000.

[48] Drucker, Peter F., Management: Tasks, Responsibilities, Practices, Apr 1993.

regionalization of personnel services in the DON has significantly increased the time it takes to fill jobs.[49]

The recommendation to give laboratory directors wider authority over their support functions is a theme found in many previous studies of the DoD laboratories. For example, some 40 years ago, the Bell Report recommended *"Delegating to research laboratory directors more authority to make program and personnel decisions, to control funds, and otherwise command the resources which are necessary to carry out the mission of the installation."*

The Adolph Commission too worried about centralization of support functions, noting "*an effective laboratory has sufficient local operating authority to execute* [its] *responsibilities in a rational, effective manner. Laboratory management must have authority to plan, organize, staff, and direct its technical program as well as all necessary support services to ensure that the technical program is not impeded by inadequate support. The support services should be organic to the laboratory*."

As the *Quiet Crisis* points out "*the effects of this excessive control can be delays in facility and equipment procurement that, in turn, delay R&D projects, some of which are critical to national security requirements, or lengthen the time it takes to process personnel actions, thereby exacerbating the difficulties in recruiting high-quality S&Es. These bureaucratic constraints can threaten work quality and employee morale to the point where a talented researcher concludes that the system is unworkable, and he or she departs for employment in industry or academe*."

To date, DoD laboratories have managed to cope, albeit with ever increasing difficulty, with excessive control by finding "work-arounds." However, as laboratory overhead and resources decline, the ability to make the system work despite impediments is rapidly deteriorating.

In addition to centralization, another growing problem is that support staffs at most laboratories have been slashed in the last several years, primarily in response to a succession of mandates to reduce laboratory overhead costs. One result is that the S&Es now find they spend an increasing portion of their time doing tasks formerly performed by support personnel, for example clerical functions such as typing and copying. This was a common complaint from S&Es interviewed by the Panel during their visit to the three corporate laboratories.

In summary, many of the DoD and Services centralization and overhead reduction initiatives have been driven almost completely by the desire to cut costs. Almost no attention has been given to the impact on the delivery of services to the customer, and the impact this can have on the direct mission of affected organizations like the laboratories, including their ability to hire and retain top quality S&Es.

[49] "Civilian Workforce 2020: Strategies for Modernizing Human Resources Management in the Department of the Navy," National Academy of Public Administration, (NAPA 2020 Study), 18 Aug 2000.

Past Studies of Laboratories

Consistent Picture of Problems

As already noted, there have been numerous studies of the DoD laboratories. A review of these past studies shows that their conclusions and recommendations have been remarkably consistent. Among the common problems identified in these studies are the following:

- Salary/benefits for top S&Es well below industry and academia for the best and brightest (90^{th} percentile).
- Adequacy of research budget, and program stability.
- Aging, substandard facilities and equipment.
- Erosion of pride in public service.

These studies also offered more or less the same solutions:

- Modify the Title 5 Civil Service System to improve workforce shaping (hiring/firing/downgrading).
- Increase pay (variety of mechanisms proposed).
- Give the laboratory directors more authority over their resources.
- Change the laboratory governance model.
- Obtain technical staff from the private sector (academia, industry, UARCs, FFRDCs).
- Create an OSD-level champion for the laboratories.

Many of these studies predicted that the quality of the staffs of the laboratories and the quality of their work would decline unless reforms were undertaken. The Panel, during its visit to the three corporate laboratories, found some evidence that this decline is underway. Importantly, the current demographics of the laboratories, as evidenced by the graying of the workforce, suggest this decline will accelerate in the next few years unless immediate steps are taken to fix the problems.

Previous Laboratory Reform Efforts Have Been Marginal

The record of these past studies also shows that few of the recommendations made have been implemented. And most that have largely involve incremental, piecemeal, efforts, that have had only marginal effect in terms of solving the problems identified. For example, over the past 15 years, several large, well-documented programs (LDP, NPR, LQIP) have attempted to implement many of the reforms identified by previous studies. Despite thousands of work-hours of effort, these programs have generally produced no meaningful changes to the existing system in which the laboratories must operate.

The most ambitious of these programs was the LDP, established by the DoD in response to a prescient 1987 DSB Report. Despite a series of specific written directives issued by the DEPSECDEF, few of the more than 50 laboratory-related initiatives were ever implemented in any form, and most of the problems identified by the 1987 DSB study remain un-addressed.

Immediate Action Required

Although the DoD laboratories are still quality research institutions, many indicators are tending negative, and all of the laboratories visited reported increasing difficulty in performing their unique missions under a growing administrative and bureaucratic burden. Maintaining a quality scientific and engineering staff is growing more difficult, with the most serious problems relating to the Title 5 civilian personnel system under which they labor. However, each of the laboratories reported other serious problems that impede their ongoing struggle to maintain world-class research programs.

Overall, it appears the laboratories are still able to carry out their assigned missions. But they are largely able to do so because of work-arounds, perseverance, commitment, and dedication. Still, as noted, there are many negative indicators. Unfortunately, quantifying the situation is difficult, and based primarily on evidence that is largely anecdotal and subjective, though much has been documented in numerous past studies.

The Panel believes that immediate action is required. The Panel also believes that the accumulated conclusions of knowledgeable and credible people, as documented in the many past studies of the labs, must be trusted, accepted, and acted upon. Failure to act immediately is likely to jeopardize the future security of the U.S.

Congress Has Tried to Help

From time to time, the Congress itself has offered legislation to encourage laboratory reform. Notable among these is the 1978 and 1994 legislative actions that authorized personnel demonstration projects. More recently, the Congress has offered several new pieces of legislation to help revitalize the laboratories and make them more effective. Much of this legislation also reflects a cautious, incremental, approach that relies on limited-term pilot programs in selected areas of operation.

Personnel Demonstration Projects

Perhaps the most important of these legislative interventions to date are provisions establishing a series of personnel demonstration projects. These demonstrations, first authorized by Title 6 of the CSRA of 1978, permitted the Director of the OPM to waive personnel laws and regulations for Federal agencies willing to test innovations in human resources management. The law prescribed that no more than ten pilot efforts could be active at any one time. They were also limited to five years in duration and to no more than 5,000 employees.

The first of these was the now famous “China Lake” demonstration project. It actually encompassed two Navy RDT&E centers, both of which reported to the Director of Navy Laboratories (DNL). These were the NWC at China Lake, California, and the NOSC at San Diego, California. This demonstration, set up in 1980, operated for 14 years before it was made permanent through legislation in 1994. It tested a flexible classification system in which similar job occupations were grouped into five career paths: professional, technical, administrative, technical specialists, and clerical. Each of these was divided into broad pay bands incorporating two or more general schedule (GS) pay grades. The other noteworthy feature of the project was performance-based pay, i.e., salary increases and bonuses were contingent on job performance rather than time in grade alone.

These and other features of the personnel demonstration projects have been widely discussed, and so will not be described here other than to say that the evaluation of the China Lake personnel demonstration project by OPM found: it reduced turnover of high performers; increased turnover of low performers; increased employee pay satisfaction; and provided administrative cost savings through reduced paperwork and less time spent on tasks such as job classification.[50] A study by the DNL also examined the China Lake demonstration's impact on hiring and retention. This study showed that the personnel demonstration participants (NWC and NOSC) were more successful in recruiting S&Es with advanced degrees and with higher grade point averages than were RDT&E centers that did not participate.[51]

Several other personnel demonstration projects have also been completed and made permanent. These include one at the National Institute of Standards and Technology (NIST), and one at the Department of Agriculture. The NIST demonstration, also pronounced a success by the OPM, has a number of features that also commend its use in a research laboratory environment.[52]

Of more interest here are several recently established personnel demonstration projects still underway at selected DoD in-house laboratories, including ARL, AFRL, and NRL. These projects were authorized by Congress in Section 342 of the National Defense Authorization Act (NDAA) for FY 95 (Public Law 103-337). The enabling legislation permits eligible S&T Reinvention Laboratories to implement more flexible personnel systems modeled generally after the China Lake project. This legislation follows the requirements of the CSRA[53], but differs in two respects:

- The Secretary of Defense has authority to conduct the project with the approval of the Director of OPM.

- There are no limitations on the number of employees and duration of the project, or on the number of demonstration projects that can be on-going at any one time.

These demonstrations aim to provide increased effectiveness through more flexible and responsive personnel systems; greater managerial authority over human resources management; recruiting, developing, and motivating a high-quality workforce; and adjusting workforce levels to meet changing program and operational needs. Some of the key features include: pay for performance; simplified classification procedures through broadbanding; expanded employee development; distinguished scholastic achievement appointment; modified term or contingent appointment; expanded probationary period; and modified reduction-in-force procedures.[54]

Although the Section 342 personnel demonstrations have produced successes, the Panel concluded that they could have been of much greater value had their vision been truly realized.

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[50] See the NAPA 2020 Study report for a summary of the benefits achieved by this demonstration.
[51] Marshall, Michael L., and Stewart, Cheryl S., "An Analysis of Science and Engineering Hires at the Navy RDT&E Centers (FY 1983-1989)," Director of Navy Laboratories Corporate Projects Office, June 1990.
[52] Office of Personnel Management, "Summative Evaluation Report, National Institute of Standards and Technology Demonstration Project: 1988-1995," 27 Jun 1997.
[53] Title 5 United States Code, Chapter 47.
[54] NAPA 2020 Study, Appendix O.

As noted in Section 4 of this report, the LQIP was formally approved as a Reinvention Laboratory in March 1994. A few months later, Congress passed Section 342 of the FY 95 NDAA, which authorized personnel demonstration projects generally similar to the China Lake project at DoD laboratories designated by SECDEF as "S&T reinvention laboratories". DDR&E eventually approved as S&T reinvention laboratories all those nominated by the Services, and designated the LQIP Personnel Subpanel as its agent to administer the Section 342 demonstration projects.

The DDR&E provided the following guidance to the Personnel Subpanel: (1) the Services were to decide on their respective laboratories' proposals; (2) the use of a variety of personnel system approaches would be supported; and (3) the subpanel would serve as gatekeeper and primary interface with OPM on the realm of the possible, work with each Service, and assist with ideas and collate the variety of approaches.

DDR&E and the Service and laboratory representatives pushed for an integrated processing team approach for each demonstration (laboratory, Service, OSD, and OPM representatives) with limited success. Initially, the process developed by OPM and OSD involved concept papers and multiple joint meetings with staffs before a draft Federal Register notice detailing a proposed demonstration could be submitted for staffing and approval. Actual staffing of the draft Federal Register notices was sequential. Later, joint meetings with OPM and OSD were discontinued at the direction of Deputy Assistant Secretary of Defense (Civilian Personnel Policy) (DASD(CPP)).

Many of the more promising or innovative initiatives were excluded or dropped as a result of verbal direction from either OPM, OSD, or both (see Appendix F). These included initiatives pertaining to the Senior Executive Service (SES) system; direct-hire authority for S&E's; authority to appoint 1-3% of S&E positions as Science and Technology (ST) positions; an S&E salary-setting system based on market rates; authority to approve Voluntary Early Retirement Authority (VERA) and expand the conditions under which it could be used; authority to approve Voluntary Separation Incentive Pay (VSIP) and set the amounts; authority to modify qualification standards (e.g., require degrees); include locality pay in pay pools; authority to conduct "business-based" reductions-in-force (RIFs); broadbanding for Federal Wage System positions; and elimination of the dual compensation restrictions for retired military researchers.

Each of the two China Lake personnel demonstration projects took about 12 months from development to OPM approval. In contrast, the first Section 342 S&T personnel demonstration took two years to go from beginning of development to approval, and each subsequent demonstration has taken longer to be approved by OSD than the one before, even though many of the features and wording were nearly identical to previously-approved demonstrations. The first demonstration approved by OSD and OPM (AFRL) took a year of staffing within OSD and OPM. The remaining demonstrations required an average of two years for approval.

In their presentations to the Panel, NRL, ARL, and AFRL all described the benefits they were deriving from participating in the Section 342 personnel demonstrations. However, the Panel came to two additional conclusions:

- The organizational view at OPM (and to a lesser degree within OSD) is that the Section 342 demonstration authority is a test of new and liberalized personnel procedures, and so must be carefully controlled through the use of such features as budget neutrality, control laboratories, independent evaluations, and a conservative interpretation of the words "generally similar in nature to the China Lake demonstration project" in Section 342 of the FY 95 NDAA.
- By contrast, faced with the lack of any other meaningful reforms to the civilian personnel system employed by the DoD laboratories (despite the dozens of studies recommending such action), the laboratories have seized upon the limited authorities provided under Section 342 as the only tools available to them to try to remain competitive in the marketplace for S&E talent.

A recent, and perhaps noteworthy, change to this 1995 law was included in Section 1114 of the NDAA for FY 01 (*Clarification of Personnel Management Authority Under Personnel Demonstration Projects*). This amendment eliminates the requirement for OPM review and approval of S&T Reinvention Laboratory personnel demonstrations, turning this function over to the SECDEF. The expansive language of Section 1114 also appears to give the Secretary OPM-like authority to appoint and compensate employees of the participant laboratories, in effect allowing the Secretary to rewrite the rules for things like pay and hiring. Additionally, Section 1114 eliminates certain salary caps for S&Es. However, there appear to be potential conflicts between this law and other maximum compensation laws, and these will likely require resolution before any pay cap action can be taken. More specifically, this section eliminates limits on base pay, but is silent on a separate Title 5 limit for base pay plus locality pay, and a limit on base pay plus all other pay.

Other Reform-Oriented Legislation

There have been other recent attempts by Congress to enable laboratory reform in selected areas. For example, in the NDAA for FY 99, Section 246 (*Pilot Program for Revitalizing the Defense Laboratories and Test and Evaluation Centers of the Department of Defense*), Congress authorized pilots at three "S&T laboratories," and three "T&E centers" to explore innovative partnering with academia and the private sector.[55]

The law that established the Section 246 pilot required the SECDEF to report on its implementation to Congress. Specifically, the report was to identify participating laboratories and centers; describe the innovative concepts to be tested in the pilots; and delineate the criteria for measuring success. The legislation also called for a final report to Congress including things such as the results, lessons learned, and proposals for additional legislation. The initial report was provided in July 1999.[56] It briefly described a number of proposed initiatives in three broad areas: partnerships, people, and facilities.

The Section 246 pilot may be extended. However, it appears that its success may be limited unless the authorities described in the original statute are expanded by Congress. Under the terms

[55] Public Law 105-261, 112 Statutes 1920.

[56] Office of the Undersecretary of Defense, Report to Congress on "Pilot Program for Revitalizing the Laboratories and Test and Evaluation Centers of the Department of Defense, A Report in Response to Section 246 of the Strom Thurmond National Defense Authorization Act of FY 1999," July 1999.

of its legislation, the SECDEF is to delegate to directors of participating laboratories and centers authority "*to waive any restriction on the demonstration and implementation of such [innovative] methods that are not required by law.*" In practice, laboratory directors faced significant restrictions in exercising this delegated authority by the legal interpretation accorded this provision by OSD legal counsel and others. As a result, all efforts to use Section 246 authorities to waive burdensome regulations in the areas of civilian personnel and facilities renewal had to be abandoned. At best, this pilot is likely to produce only marginal fixes to problems that confront in-house laboratories in their efforts to collaborate with academia and industry.

The Congress included two more laboratory reform provisions (Sections 245 and 1107) in the NDAA for FY 00.[57] Section 245 (*Additional Pilot Program for Revitalizing Department of Defense Laboratories*), closely patterned after Section 246, also authorized additional three-year pilots, this time to demonstrate innovative personnel initiatives. The intent was to help in-house laboratories and centers attract *"a workforce appropriately balanced between permanent and temporary personnel and among workers with an appropriate level of skills and experience and that those laboratories can effectively compete in hiring to obtain the finest scientific talent*." Again, the provision instructed that the participant laboratory and center directors have authority to waive obstructive rules. As of this writing, it appears that Department officials have been unable to agree on the details for delegating this authority, and the Section 245 pilot efforts have not been implemented.

In Section 1107 (*Exemption of defense laboratory employees from certain workforce management restrictions*) Congress directed the Department to eliminate controls on the number of high-grade scientific and engineering positions. This direction was implemented on 21 November 2000 when the Services were advised that the DoD high-grade control program was being discontinued at the S&T demonstration laboratories. However, high-grade controls remain in effect at other RDT&E activities not designated as S&T demonstration laboratories. Restrictions on such positions have long contributed to attrition among journeyman-level S&Es at the in-house laboratories.

The NDAA for FY 01 contained further legislative provisions aimed at the in-house laboratories. These included Sections 1113, 1114, 1151, 1152, and 1153. Only brief discussions of these sections are provided here.

Section 1113 (*Extension, Expansion, and Revision of Authority For Experimental Personnel Program for Scientific and Technical Personnel*), deals with an authority previously granted by Congress to the Defense Advanced Research Projects Agency (DARPA) by Section 1101 of the NDAA for FY 99. In effect, Section 1101 authorized an experimental five-year program to "*facilitate recruitment of eminent experts in science and engineering for research and development projects administered by* [DARPA]." Specifically, it gave the Secretary power to appoint 20 S&Es from outside the Civil Service and uniformed Services to DARPA "*without regard to any provision of title 5, United States Code, governing the appointment of employees in the civil service*." Terms were limited to four years, with the proviso that the Secretary could extend this by up to two years should he determine such action is "*necessary to promote the*

[57] Public Law 106-65, 113 Statutes 512.

efficiency of [DARPA]." The authority also allowed the Secretary to prescribe the rates of basic pay and to offer additional pay, subject, however, to certain limitations.

Section 1113 extends DARPA's authority to recruit term employees to the Military Departments, by giving each Service authority for forty such positions. Details regarding extension of this authority to the Services are still being worked by OSD and the Services. The Panel believes that if not burdened with unnecessary bureaucratic impediments (DARPA's process is quite straightforward), this authority would be very useful to both the laboratories and such headquarters S&T management organizations as the ONR. Unfortunately, current evidence suggests that some or all of the Services will treat the Section 1113 positions like other "supergrades" (i.e., SES, ST, and SL positions) and retain at the Service headquarters the authority to approve salaries higher than SES-4.

Section 1114 (*Clarification of Personnel Management Authority*) has already been mentioned in the discussion of personnel demonstration projects above. This legislative provision appears to offer the possibility of broad relief for the S&T Reinvention Laboratories participating in the 1995 personnel demonstrations. Realizing this potential will depend largely on the OSD's interpretation and emphasis.

Section 1151 (*Extension, Revision, and Expansion of Authorities for Use of Voluntary Separation Incentive Pay and Voluntary Early Retirement*), Section 1152 (*Department of Defense Employee Voluntary Early Retirement Authority*), and Section 1153 (*Limitations*) were included to allow the DoD a more orderly and targeted downsizing process. The amendment limits the use of these provisions in FY 01 to employees eligible for optional retirement, and requires reauthorization by the next Congress before the provision may be used in fiscal years 2002 and 2003.

Discussions with personnel in the OSD indicate that other legislative proposals to Congress may be forthcoming. One of these extends the existing Intergovernmental Personnel Act (IPA) mobility program to allow the Federal Government to exchange personnel with industry, creating so-called "commercial IPAs".[58] At present, exchanges are limited to personnel from state and local governments, institutions of higher education, and other non-profits, and are intended to facilitate temporary exchanges of skilled personnel. Such IPA assignments permit hiring of personnel for limited terms without the usual competition constraints associated with other vehicles such as contracts. Employees exchanged under an IPA assignment are able to act with nearly the same authority as Federal employees without restriction, i.e., they can perform inherently governmental functions, something strictly forbidden for contractors.

Creating exchanges between the Government and a for-profit commercial entity would raise a myriad of ethical and legal issues that do not arise in the current IPA assignments. For example, could commercial IPAs manage Government employees or perform inherently governmental functions, such as policy-making or committing the Federal Government to a course of action (e.g., a contract)? If not, this would greatly limit their utility. It remains to be seen whether the

[58] The legal authority for Intergovernmental Personnel Assignments is Title 5 United States Code, Sections 3371 through 3375.

Department will ask the Congress for legislation to create a commercial IPA authority and, if so, what form it might take.

Other legislation currently being considered would increase hiring bonuses that in-house laboratories could pay, possibly up to 100 percent of salary, payable over a four-year period (25% per year).

Near- and Long-Term Strategy

Hiring the best and brightest S&Es

The real issue is not whether the laboratories can muddle through under the current system and fill S&E vacancies with entry-level personnel. It is whether they can compete effectively for, and retain, the best and brightest technical talent, e.g., the top 10 percent.

Those that defend the current Title 5 personnel system as being "good enough" often point out that DoD-wide data do not prove that the laboratories have a problem recruiting and hiring S&Es. However, such "average" data generally include many non-S&T organizations and personnel. This masks the kinds of problems the corporate laboratories have overall, and especially as regards those with advanced degrees in such high-demand technical areas as information technology, biotechnology, nanotechnology, etc. Peter Drucker, the well-known management expert once commented:

> *"In most personnel matters events are measured in averages…the averages serve the purposes of the insurance companies, but they are meaningless, indeed misleading, for personnel management decisions."*[59]

This is especially true in matters related to hiring technical staff for a research laboratory. For such a laboratory to be world-class, at least 10 percent of its S&Es must be exceptionally talented. Therefore, the DoD corporate laboratories must be able to compete effectively for top technical talent, not just any anyone who holds a degree in science or engineering.

Title 5 Hinders Talent War Efforts of Laboratories

Civilian personnel at the DoD laboratories are employed under the competitive Civil Service System regulated by Title 5 of the United States Code.[60] This system was established by the 1883 Pendleton Act, which sought to "remove partisan political influence from the selection and retention of civil servants. This system was instituted to deal with the problem of political patronage then rampant. Most of the procedures currently employed by the Civil Service system were established shortly after World War II, when there were a large number of applicants for a relatively small number of secure, well-paying Federal Government jobs. Yet, today, the DoD laboratories are still having to rely on this archaic system, designed to hire low-level Government clerks, as their tool for recruiting, retaining, and rewarding PhD-level physicists and engineers.

[59] Drucker, Peter F., The Effective Executive ((New York: Harper & Row, 1966).
[60] The competitive Civil Service comprises both General Schedule and Wage Grade employees.

The body of Federal law included in Title 5 has expanded over the years into 790 finely printed pages controlling every aspect of the Federal Civil Service process. It covers hiring, employment, training, performance management, pay, incentives, labor relations, attendance, and benefits. Perhaps even more burdensome are the 1,310 pages in the Code of Federal Regulations that contain the detailed instructions written to implement this law.

The resulting system has become ponderous, bureaucratic, slow, and unresponsive to the needs of 21st century organizations. Not surprisingly, some 28 Federal agencies now operate outside Title 5 (and the new Homeland Security Agency desires, for obvious reasons, to be the 29th). They represent 50 percent of all Federal civilian employees. Their exemptions are based on a number of factors, including national security and secrecy needs, and the need to operate more like a commercial business. Examples here include the Defense Intelligence Agency (DIA), the National Security Agency (NSA), and the Central Intelligence Agency (CIA). Table 1 provides a list the agencies that are currently exempt from Title 5.

Tennessee Valley Authority	**General Accounting Office**
United States Postal Service	**Government Printing Office**
Federal Aviation Administration	**Office of the Architect of the Capital**
Metropolitan Washington Airport Authority	**The Peace Corps**
Smithsonian Institution—Trust Employees	**Foreign Agricultural Service**
Botanical Garden	**Department of State—Foreign Service**
Federal Reserve Board	**Veterans Health Administration**
Federal Deposit Insurance Corporation	**Atomic Energy Commission**
Office of Thrift Supervision	**Nuclear Regulatory Commission**
Office of the Comptroller of the Currency	**National Security Agency**
Sallie Mae	**Central Intelligence Agency**
Office of Federal Housing Enterprise	**Defense Intelligence Agency**
Library of Congress	**National Imagery and Mapping Agency**
Defense Exchange System	**Virgin Islands Corporation**

Table 1: Title 5 Exempt Agencies

Virtually every study of the DoD laboratories has concluded that the Title 5 Civil Service System is not responsive to the dynamic personnel needs a 21st century laboratory. In fact, most recent studies have concluded that Title 5 can never be made to work for the laboratories. For example, the National Academy of Public Administration recently studied the civilian personnel problems confronting the Department of the Navy, and concluded Title 5 was hopelessly out of date and that a whole new personnel system was required.

In addition, the February 2000 DSB Task Force *Report on Human Resource Strategy*, which documented the pervasive human resources problems plaguing the DoD points recommended "*that DoD propose legislation amending, as necessary, appropriate provisions of the United States Code (title 10 and title 5) to transfer authority for the Department's civilian workforce from the Office of Personnel Management to the Secretary of Defense*."

The current limitations of the Civil Service Personnel System as a workforce-shaping tool are well known. These include a recruitment/hiring process that is slow, labor-intensive, and

bureaucratic, a problem further exacerbated by the centralization of human resource functions in regional offices. The current system also limits the compensation that can be paid to employees at a time when compensation is already uncompetitive for senior-level personnel and, in many disciplines, at all levels. A 1999 study[61] carried out by professor Howard Risher of the Wharton School, as part of an OPM S&T personnel demonstration, found that:

- Salaries paid to engineers in the commercial R&D sector are among the highest,
  - Exceeded only by those paid in chemical, drugs, plastic sectors.
  - True across full distribution of salaries, including those for new engineers.
- At the 90th percentile, Federal salaries are lower than those in industry for all sectors.
- The most serious problem facing the Federal Government as it tries to renew its civilian workforce is low salaries.
- Management and supervisory salaries are a particular concern for the Federal Government.

Adequate compensation is a critical consideration in terms of the laboratories' ability to hire the best and brightest management, supervisory, and scientific and engineering personnel. For example, the salary of the director of the Naval Research Laboratory, an $800 million/year research enterprise, is $133,000 per year—far below comparable positions in industry and academia, including many with far less demanding responsibilities.

The bottom line is that inadequate compensation is now posing a major impediment to the corporate laboratories in their efforts to hire the best and brightest talent.

Compensation is Important, But Not the Only Important Factor

As noted, the Panel visited each of the three corporate laboratories: NRL, ARL, and AFRL. During the visits, the Panel held discussions with a cross-section of laboratory managers and bench-level S&Es. These "focus group" meetings revealed that not all S&Es are motivated by the same things, but the list of primary attractors is relatively short. It includes an opportunity for continued career growth; important, interesting, and challenging work; and adequate and stable funding, among others. Not surprisingly, these factors are not unlike those that have appeared in various published surveys.[62] In fact, most of the recruiting successes the DoD laboratories have had in recent years can be attributed to the fact that they still offer interesting, challenging research projects, and will support such research work over the long term if it offers the promise of enhancing the performance of current or future warfighting systems.

As a result of the discussions it held with laboratory personnel, the Panel believes that future recruitment efforts would be enhanced if they were based on a better of understanding of what motivates today's young PhDs in science and engineering. For this reason, the Panel considered

[61] Risher, Howard, "Engineering Salaries in R&D—1998, A Comparison of Federal Salaries with Pay Levels in Industrial R&D Organizations," Study by the Office of Personnel Management, Personnel Resources & Development Center, 1999.

[62] See for example KPMG/Canadian Advanced Technology Alliance: "High Tech Labour Survey: Attracting and Retaining High-Tech Workers," 5 Jun 1998; "High-Technology @ Work™," AON Consulting Workforce Commitment Report, 2000; "What Do Employees Really Want? The Perception vs. The Reality," Report by Korn/Ferry International in conjunction with the Center for Effective Organizations, Marshall School of Business, University of Southern California, 2001.

that there may be value for the Services to charter a follow-on effort to survey recent graduates to better understand the characteristics they seek in their careers.

Laboratory Infrastructure Renewal Rates Inadequate

The Panel also heard evidence that laboratory infrastructure renewal rates are inadequate for top-quality research institutions. The problem seems to be especially difficult as regards general-purpose laboratory space. This finding accords with previous studies which have pointed out that funding levels for Federal R&D facilities are inadequate, with that for the DoD laboratories among the worst. For example, in 1991, the DoD backlog of unfunded repairs to research facilities was $850 million. Little progress has been made in reducing this backlog since then. In a 1993 study, the GAO stated many Federal laboratory facilities could not be upgraded to meet current R&D requirements, and recommended demolition and new construction instead.[63]

This poses particular problems for laboratory space that often costs 3 or 4 times as much per square foot than conventional office space. The National Research Council and the General Services Administration standard for annual cost of maintenance and repair (M&R) of typical facilities is 2-4% of plant replacement value (PRV), not including reduction of backlog of deferred repairs. However, in the 1990s, the Navy invested only 1.6-1.9% annually on M&R overall, and attempted to impose such limits on its laboratories as well. For FY 01, the Navy estimated M&R funding of 2.1% of PRV was required simply to stop the growth of the backlog.

The basic problem is that DoD laboratories must depend on Congress for the appropriation of specific MILCON funds for each building project. But, laboratory facilities are not considered "mission critical" infrastructure by the Services and DoD, and consequently do not compete well for such funds against such projects as runways and child-care centers. Specific legislation would be required to break the link between MILCON funds and laboratory facility construction.

It should also be noted that MILCON funds for new construction do not include money for furnishing the building, e.g., scientific equipment in the case of a laboratory. The Services use internal funds for such purposes. However, complex financial regulations imposed by the Services often limit how much can be spent on equipment, thereby preventing the laboratories from being able to procure state-of-the-art equipment in many instances.

Perceptions About Government Work Hurt Recruitment & Retention

It has already been seen that pride in public service and institutional pride are important factors to those considering a career in the Federal Government, including work in a DoD laboratory. It has also been seen that pride in public service has been on the decline for several years. Arguably, it has been affected more severely in the DoD than in most other Federal agencies, largely as a result of extensive cutbacks and post-Cold War downsizing. Indeed, the continuing search for "infrastructure savings" has resulted in a multitude of initiatives aimed at cost cutting in the DoD. A prominent example is the forced outsourcing of work to the private sector, including contracting out technical work.

[63] General Accounting Office: "Federal Research: Aging Federal laboratories Need Repairs and Upgrades," GAO/RDED-93-203, September 1993

This drive to find savings has frequently been accompanied by Administration policies and/or statements that either directly or by implication denigrate the laboratories and their employees. For example, the commonly reiterated claim that the private sector can do work "*better, cheaper, and faster"* carries the implication that in-house defense workers do lower quality work, cost more, and work more slowly. This is not a message that instills pride of public service in current employees, or those who might consider employment in the Department. Such perceptions about the DoD laboratories are not infrequently reinforced by comments from private-sector defense company executives.

Recent DSB studies have also contributed to the perception that the best and brightest S&Es do not work in the DoD laboratories. The 1999 DSB study, "21st Century Defense Technology Strategies," commented that Service laboratories *" are not competitive with leading industrial and university laboratories in terms of innovation and technical leadership*." The following year, the DSB study on "DoD Science & Technology Funding," remarked that "*DoD laboratory directors are unable to obtain or retain the services of not only the "best and brightest" scientists and engineers but even those of average quality.*"

Many such statements are unsupported by data. Some are actually contradicted by the facts, yet they are often widely reported, and continue to erode the pride many highly respected scientists and engineers have taken in their work for the DoD laboratories.

Cultural Impediments to Reform

The authority of DoD laboratory directors over their resources and management and support services has undergone sustained and significant erosion. Areas affected include authority to hire and fire employees, and authority over basic support services (e.g. human resources, public works, finance and accounting, travel). These directors are also limited in their ability to procure equipment, renew facilities, and transfer personnel.

Unfortunately, many of those who would be key to reform believe no action to remove impediments is needed — they consider the Title 5 Civil Service System to be "good enough." As evidence in support of this view, they point to the fact that candidates still apply for job openings. But there is a vast difference between hiring anyone and hiring the best and brightest talent on the market — the top 10 percent.

This cultural impediment to reform is compounded by the fact that many OSD and Service staff offices outside the DDR&E organization (e.g. general counsel, comptroller, human resources) believe that we must treat all organizations in the same way, and strenuously resist exceptions to the existing system. Even authorities specifically granted by Congress, such as pilot programs and limited-term demonstrations, are given the most conservative interpretation consistent with the legislative language, and then implemented, if at all, only after great deliberation. This philosophy, manifested by an enduring belief in a one-size-fits-all system, is strong throughout Government, and is simply the logical behavior of a large bureaucracy that is fearful of getting its hands slapped whenever anyone in the system makes a mistake. Unfortunately, this mentality poses a significant impediment to laboratory reform and must be dealt with when encountered.

Practical Impediments to Reform

There are other, more practical, impediments that also hamper efforts to reform the laboratories. For example, because of the bureaucratic tendency to resist change, senior leadership at all levels must make an unequivocal commitment to endorse exceptional reforms, and insist subordinates implement them. That is, for efforts to succeed, decision-makers at all levels must make reform a high-priority issue, and take the time to understand the issues and the solutions proposed. And they must demonstrate a continuing commitment to implementation of their decisions.

Service Differences Must Be Considered in Crafting Reform

As pointed out elsewhere in this report, each of the Services has developed its own approach to its Title 10-mandated research, development, and acquisition process. This has led to significant differences in the way the Services operate their laboratories. Moreover, there are significant differences between S&T-focused laboratories such as the Service corporate laboratories, and the product-oriented centers. These include funding mechanisms (e.g. working capital vs. appropriated funds), ownership or non-ownership of support services, funding mix, in-house/out-of-house performance ratios, etc. The differences between S&T-focused laboratories and product centers are especially important in the context of this study. Thus, when formulating recommendations, it is important to remember that the Service corporate laboratories have a business base largely composed of S&T work (6.1, 6.2, 6.3); have a much higher percentage of PhDs in their technical workforces; and are more focused on discovery and invention than on engineering and testing.

An important point is that most previous studies have failed to understand these differences and to factor them into their recommendations. Failure to recognize and accommodate important Service differences leads to lack of consensus among those who have to implement such recommendations, and to watered-down reforms—a one-size-fits-all reform package. For reform to succeed, such differences must be considered. This also means that OSD and the Services must be in agreement on the nature of the problems and recommended solutions.

Funding Support for New Hires is Critical

One of the issues that came up during the Panel's visits to the corporate laboratories was that of funding, especially for new or recent hires. Lack of stable funding for new hires, especially those engaged in basic research, can impede efforts to recruit. Part of the problem is that many managers (who are key to recruiting new employees) worry that they will be unable to provide funding for new hires. This makes them cautious about hiring, and so less willing to actively recruit.

During its visits, the Panel also heard concerns from some of the new hires over pressure to obtain funding for themselves. Turnover is high in the first few years of employment under any circumstances, and can be exacerbated by the lack of stable funding. Therefore, the Panel considers that there may be value in establishing mechanisms for ensuring (at least) partial support for new S&E hires, especially those working on basic research, for the first one or two years of employment. This would relieve some pressure on new hires to obtain their own funding, and create an environment more attuned to hiring and retention at the entry level.

Improved Communication Would Benefit Retention

In all of the laboratories visited, the Panel found evidence that communication between senior leadership, middle-level management, and new employees is less than optimal, and should be improved. Many of the newer employees seemed to lack an understanding of what it takes to advance their careers (e.g., requirements for promotion), and other basic facts regarding their employment situation. The Panel also heard many employees voice concern over lack of information on the laboratory's performance appraisal system, e.g., how pay is linked to performance.

This lack of basic communication may be having an effect on employee morale, hence on retention. As a mitigating factor, it might be noted that some of the problems in this area may have been exacerbated by recent implementation of new personnel demonstration programs at the three corporate laboratories. The Panel believes that it is important for the laboratory directors to take more aggressive steps to insure proper structuring of laboratory careers and mentoring of new employees.

Military S&Es in Laboratories an Asset

During its visits, the Panel noted that the number of military officers with advanced degrees in science and engineering is declining, especially in the Army and Navy corporate laboratories. Such officers have, in the past, provided a vital link between the work in the laboratories and the operating forces. Such links could be even more vital in the future, given the growing reliance on technological superiority as a force multiplier.

The Panel unanimously agreed that the role of uniformed S&Es in the laboratories is very important, and is concerned that the Services are not fully exploiting this capability. Although this issue was not thoroughly investigated (it was not formally stated in the study TOR), the Panel believes that the Services could improve development, support, and promotion of uniformed S&E personnel to their considerable long-range benefit. Therefore, the Panel urges further investigation of this important topic.

A tour in a laboratory or product center should be considered as one of several possible career-enhancing (rather than the opposite) assignments available to a junior officer, no matter what his/her background and specialty. An understanding of how new war-fighting technologies and systems are developed is certainly an important as understanding the intricacies of the Planning, Programming and Budgeting System (PPBS) process.

Summary of Findings

The role of the DoD laboratories is essential and critical.
The essential elements of a world-class S&T laboratory include a high-quality technical staff, state-of-the art facilities and equipment, and important and challenging work.
Past studies of the DoD laboratories: ❑ **Provide a consistent picture of the problems.** ❑ **Support the view that immediate action is required to fix them.** ❑ **Show that, to date, reforms to the system have been marginal.**
Congress has tried to help, but few legislative authorities have been utilized effectively.

Both a near-term and a long-term reform strategy are required, and should be based on the following findings:

- **Acknowledgement that the DoD laboratories must be able to compete effectively for top technical talent (top 10%).**
- **The current Title 5 personnel system prevents the laboratories from competing for such talent.**
- **Compensation is important, but not the only factor in attracting and keeping an outstanding S&E workforce at the laboratories.**
- **Current laboratory infrastructure renewal rates are inadequate.**
- **Perceptions are hurting the ability of the laboratories to attract and retain required technical talent.**
- **Cultural impediments to reform include: a view widely held in OPM and parts of OSD that Title 5 is good enough; a complex, slow, unresponsive, and burdensome bureaucracy that inherently resists change; and processes for laboratory infrastructure renewal that undervalue the importance of S&T facilities and equipment.**
- **Practical impediments to reform flow from the often-short tenure of political appointees and other high-level decision makers.**
- **Any actions to address the problems facing the DoD laboratories must take into account the significant inter-Service differences among them, and the way they do business.**
- **Lack of funding for new hires, especially at the PhD level, can impede recruiting and be critical to retention.**
- **Retention of S&Es would be improved by better in-laboratory communications.**
- **Military S&Es are an asset to laboratory programs and options.**

Table 2: Summary of Panel Findings

6. RECOMMENDATIONS

Recommendation #1:

The Panel recommends that the Director, Defense Research and Engineering obtain the commitment of the Secretary of Defense and the Services Secretaries to the need for, and the importance and value of, the Service Corporate Research Laboratories by demonstrating continuing support for the implementation of Recommendations #2 and #3 listed below.

This recommendation is aimed at reconfirming and advertising the Service corporate laboratories as the scientific/discovery components of the U.S. defense establishment; the DDR&E as the visible, high-level champion for the laboratories within OSD; and the SAEs as the high-level champion for the laboratories within their respective Services.

It is also aimed at obtaining commitment from the SECDEF, DEPSECDEF and USD(AT&L), and the Services, to direct staff offices under their purview to support needed corporate laboratory reform efforts.

Recommendation #2

The Panel recommends that the Secretary of Defense fully utilize the authority granted him by Section 1114 of the National Defense Authorization Act of FY 01, and any other authorities granted by Congress, to establish a separate personnel system for the scientists and engineers in the Services' corporate research laboratories.

As noted previously, Section 1114 of the NDAA for FY 01 vests OPM's authorities to manage S&T laboratory personnel demos in the SECDEF. As an urgent item, DoD should establish steering and working groups to develop guiding principles and implementing regulations for a new S&T laboratory personnel system, and advise Congress that actions utilizing Sec 1114 authority are under way.

The Panel envisions the following basic features of a proposed structure to carry out this effort:

- A Steering Group composed of the Deputy DDR&E, Service Vice Chiefs, SAE reps, and Service S&T Executives.
- Working Group members from DDR&E, USD(P&R), and the laboratory community, assisted by full-time contractor support to facilitate the work.
- The initial focus of the effort should be on three Service S&T laboratories (including ONR, ARO, AFOSR), with possible later expansion to S&T components in Service product centers, e.g. warfare centers, RDECs, etc.
- The goal should be an overarching structure with maximum flexibility to accommodate Service differences.
- Utilize phased implementation to maximize the use of the Section 1114 authority:
  - Steps OSD or Services could implement immediately without additional guidance.
  - Steps requiring development of implementing guidance.
  - Proposed Schedule:
    - Begin testing and partial implementation (in parallel with old system): Jan 03.
    - Fully implement at selected sites: Oct 03.

Recommendation #3

The Panel recommends that the Director, Defense Research and Engineering develop and propose to Congress additional legislation that would enable the Services to experiment with alternative governance structures that would address additional laboratory issues such as salary caps, facility and equipment renewal, and laboratory director authority.

Alternative governance structures for the corporate laboratories would allow them to address a number of the problems that currently hinder hiring, retention, and reward of high-quality scientific and engineering personnel, e.g. inadequate facility renewal rates, salary caps imposed by current legislative restrictions, and erosion of laboratory director authority by a variety of centralization requirements.

Many past studies have recommended that these more pervasive problems be addressed by converting them from their existing Government-Owned, Government-Operated form of governance to some alternative form, such as GOCO or Government-Owned Corporation.

The Panel believes there is merit in allowing the Services to experiment with such alternative governance models, and recommends that the DDR&E develop and propose to Congress legislation that would enable such experimentation within the context of the corporate laboratories. Such models should be based on best academic and industrial practices, and include clean-slate analyses of the unique needs of defense laboratories.

The following outline approach is recommended:

- Fully develop the pros and cons of more comprehensive alternatives requiring new legislation, e.g. Government-owned corporation, Uniformed Services University of the Health Sciences (USUHS)-like agency, GOCO, separate Title 10 authority for personnel, facilities, etc.
- Consider such factors as cost, efficiency, responsiveness to defense needs, executability, differing Service requirements, and possible impediments.
- Develop draft Plan of Action and Milestones (POA&Ms) for each possible alternative, candidate laboratory(s), and differing circumstances.
- Develop proposed legislative authorities:
  - Personnel, infrastructure and bureaucratic regulations.
    - Break the link between laboratory salaries and other Government pay.
    - Break the link between laboratory infrastructure renewal and the MILCON process.
  - Authority of laboratory directors.
  - Clear statement of uniqueness of laboratory requirements.
- OSD/Service/laboratory/contractor team led by DDR&E.
- Include provisions for accommodating Service differences and possible extension to selected parts of product centers.
- Include measures to ensure:
  - Adequate and stable funding.
  - Quality.
  - Continuing communication with product centers and operators.
- Proposed Schedule:
  - POA&M by 1 Dec 02.
  - Review by DDR&E and Services by 1 Jul 03.
  - Report to SECDEF by 1 Oct 03.

Appendix A

Panel Membership

Mr. John M. “Jack” Bachkosky (NRAC), Chief Operating Officer, System Planning Corporation (Chair)

Mr. Jeffery B. Erickson (AFSAB), Manager, Human Systems Integration, Boeing Phantom Works

Mr. Jeffrey E. Grant (AFSAB), Private Consultant

Mr. Gilbert V. Herrera (ASB), Deputy Director, Corporate Business Development and Partnerships, Sandia National Laboratories

Dr. Joseph A. Johnson (NRAC), Director, Center for Nonlinear and Nonequilibrium Aeroscience, Florida A&M University

Mr. Nat Kobitz (NRAC), Private Consultant

Maj Gen Donald L. Lamberson, USAF (Ret.) (Ph.D.) (AFSAB), Private Consultant

Dr. James R. Luyten (NRAC), Senior Associate Director & Director of Research, Woods Hole Oceanographic Institution

Dr. Malcolm R. O'Neill (AFSAB), Vice President and Chief Technical Officer, Lockheed Martin Corporation

Dr. Irene C. Peden (ASB), Professor Emerita of Electrical Engineering, University of Washington

Dr. Edward K. Reedy (ASB), Vice President and Director, Georgia Tech Research Institute

Dr. Robert C. Spindel (NRAC), Director, Applied Physics Laboratory, University of Washington

Dr. Michael A. Wartell (ASB), Chancellor, Indiana University-Purdue University Fort Wayne

Mr. Kenneth W. Lackie (executive secretary)

Mr. Michael Marshall (executive secretary)

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Appendix B

Terms of Reference

1 August 2001

NAVAL RESEARCH ADVISORY COMMITTEE (NRAC)
PANEL ON SCIENCE AND TECHNOLOGY (S&T)
COMMUNITY IN CRISIS
TERMS OF REFERENCE

BACKGROUND: This is a joint NRAC study, with representation from the Army Science Board, the Air Force Scientific Advisory Board, and sponsored by the Director Defense Research and Engineering.

Over the past 50 to 75 years, the Department of Defense (DoD) laboratories and technical centers have made incalculable contributions to the technological superiority of US warfighting forces. However, these organizations find themselves in crisis, today. This situation has been caused by a number of factors, among which are:

- Difficulty recruiting and retaining world-class scientists and engineers.
- An inability to renew aging facilities and equipment.
- An aging workforce caused by years of downsizing, hiring freezes, and very limited recruiting.
- Changes in the roles of the laboratories, themselves, caused by consolidations, closures, increased outsourcing, a lack of stability in their Research and Development (R&D) programs, transfers of headquarters functions, and a rapidly evolving world economy.

Some of these problems began more than 20 years ago; and there have been more than 100 "Blue Ribbon" studies of the DoD laboratories since the 1960s. Although some progress has been made, many of the more important recommendations resulting from these studies have not been implemented. Nevertheless, the negative trends must be reversed if the DoD is to ensure the innovative development of revolutionary capabilities for future military forces.

SPECIFIC TASKING:

1. Consider what the role(s) of the DoD laboratories should be in the 21st Century, given their situation today. Focus should be on the components devoted primarily to performing Science and Technology (S&T) work in-house. Identify the differences that do or should exist between S&T-oriented research laboratories and technical centers performing mostly acquisition support, in-service engineering, and higher-category R&D work.

2. Identify the desired characteristics of a world-class S&T laboratory in terms of professional staff, infrastructure, budgeting process, support services, etc.

3. Through briefings, or other appropriate means, review the most relevant and important past studies of the laboratories to assess the current relevance of their primary recommendations.

    a. Assess the benefits of those that were implemented and the continued applicability of those not adopted.

    b. Prioritize those that promise the greatest potential for attracting and retaining a world-class scientific and engineering staff.

    c. Identify possible reasons for past interaction, and recommend approaches to improve the opportunities for favorable action.

4. Assess the implementation status and impact of recent legislative initiatives directed to improving the DoD laboratories.

5. Assuming that future roles for these organizations can be identified, recommend both near-term steps and a long-term strategy for ensuring the excellence of the Service S&T laboratory system for the next 25 years. As a minimum, address the following areas:

    a. Scientist and Engineer recruitment, reward and retention;
    b. Laboratory facilities, equipment and infrastructure;
    c. Support services quality and control; and
    d. Identify any Service-unique approaches.

Study Administrator: RADM Jay Cohen, USN, Chief of Naval Research and NRAC Executive Director

Appendix C

Meeting Agendas

First Meeting: 18-19 October 2001

18 October (Office of Naval Research Headquarters)

0830-1000	Kickoff	Mr. Jack Bachkosky
1000-1030	DDR&E Perspective	Dr. Tony Sega
1030-1045	Break	
1045-1145	NAPA 2020 Study	Dr. Jim Colvard
1145-1200	Working lunch	
1200-1300	NASA Langley	Dr. Doug Dwyor
1300-1400	Navy S&T Exec Perspective	RADM Jay Cohen
1400-1415	Break	
1415-1515	Recent attempts to deal with Lab workforce issues	VADM Paul Gaffney
1515-1615	JHU-APL	Dr. Rich Roca
1615-1715	Army S&T Executive Perspective	Dr. Mike Andrews
1715-1730	Wrap-up	Panel Members

19 October (Office of Naval Research Headquarters)

0830-0900	Plans for the day	Staff
0900-1000	DSB Study	Dr. Anita Jones
1000-1015	Break	
1015-1115	Sandia National Labs: Competing for Hi-TechTalent in the 21st Century	Dr. Al Romig
1115-1200	Working Lunch	
1200-1300	OUSD(S&T)	Dr. Bob Foster
1300-1400	Air Force S&T Exec Perspective	Dr. Hendrick Ruck
1400-1415	Break	
1415-1515	Plans for next meeting	Panel Members

Second Meeting: 4-6 December 2001

4 December (Naval Research Laboratory)

1200-1215	Introductions & Opening Remarks	Mr. Jack Bachkosky
1215-1300	Laboratory Overview	Dr. Eric Hartwig
1300-1715	Discussions with Lab Personnel	
1715-1730	Plans for next day	

5 December (Office of Naval Research Headquarters)

0830-0900	Discussion of Study Progress	Panel
0900-1000	Hiring Strategies	Mr. Paul Villela
1000-1015	Break	
1015-1116	Research Laboratory Excellence	Dr. Tim Coffey
1115-1215	Past OSD laboratory initiatives	Dr. Lance Davis
1215-1245	Working Lunch	
1245-1345	Recent DSB Studies	Mr. Walt Morrow
1345-1400	Break	
1400-1500	RAND Study on DoD S&E Pay	Dr. Mike Gibbs
1500-1600	DoE Lab Attributes	Dr. Gretchen Jordan
1600-1630	Wrap-up	Panel

6 December (Office of Naval Research Headquarters)

0800-0830	Discussion of Study Progress	Panel
0830-0930	Panel discussion—way ahead	Panel
0930-0945	Break	
0945-1045	OSD Lab Reform Efforts	Dr. Delores Etter
1045-1145	High-Technology @ Work Survey	Mr. Peter Russell
1145-1200	Discussion of next meeting	Panel

Third Meeting: 3-4 January 2002

3 January (Army Research Laboratory, Adelphi, MD)

0915	Arrive ARL	
0930-1100	ARL Greeting/Overview	Dr. Robert Whalin
1100-1115	Break	
1115-1230	Working lunch/ARL Director's views on research laboratory excellence	Dr. Robert Whalin
1230-1400	Group I – Senior Leaders	
1400-1530	Group II – Senior Researchers/Branch Heads	
1530-1545	Break	
1545-1715	Group III – Post-Docs/New Hires	
1715-1730	Wrap-up/Discussions	
1730	Depart the Lab	

4 January (Office of Naval Research Headquarters, BCT 1, Rm. 922)

0830-0900	Discussion of Study Progress	Panel
	Sec 342 Personnel Demos -- What was	Ms. Janice Lynch
	attempted, what was approved,	Ms. Betty Duffield
900-1000	what was not, and why	

1100-1115	Break	
1115-1215	Sec 1114 Possibilities	Dominick Repici, LLD
1215-1300	Working lunch	
1300-1400	Research laboratory excellence	Dr Hans Mark
1400-1430	Wrap-up	Panel
1430	Depart	

Fourth Meeting: 5-6 February 2002

5 February (Office of Naval Research Headquarters)

0830-1000	Alternative Governance Models	Dr. Tim Coffey
1000-1015	Break	
1015-1115	Navy Civilian Workforce 2020 Study	Mr. Frank Cipolla
1115-1215	DoD laboratories: a congressional perspective	Mr. Jon Etherton
1215-1245	Working Lunch	
1245-1345	USUHS*: A Title 10 System	Ms. Mary A. Dix
1345-1400	Break	
1400-1500	Understanding Private Sector Compensation Models	Dr. Howard Risher
1500-1700	Discussion of Report Outline	Panel

6 February (Office of Naval Research Headquarters)

0830-0900	Discussion of Study Progress	Panel
0900-1000	OPM Demo Evaluation Process	Dr. Brigitte Schay
1000-1015	Break	
1015-1117	NRL Sec. 342 Personnel Demo	Ms. Betty Duffield
1115-1215	RAND Study: Pay & Quality of DoD Lab S&Es	Dr. Mike Gibbs
1215-1230	Working Lunch	
1230-1330	DoD S&T Community Issues	Dr. Craig Dorman
1330-1400	Future Plans	Panel

Fifth Meeting: 5–6 March 2002

NRAC Site Visit to AFRL
Wright-Patterson AFB
5-6 March 2002

Agenda

5 March 2002

VOQ

0745 Depart for Building 15 via DV Surrey

Building 15, Arnold-von Karman Conference Room (AvK)

0800 Continental Breakfast

0830 Welcoming Remarks	Maj Gen Paul Nielsen, USAF
0835 Administrative Notes (Dr. James Weber)	
0840 Introductions and Opening Remarks	Mr. John "Jack" Bachkosky
0855 AFRL Overview and Enterprise Issues	Maj Gen Paul Nielsen, USAF
0955 BREAK	
1010 Science & Technology Workforce for the 21st Century	Dr. James Weber
1055 Laboratory Demonstration Project	Ms. Michelle Neuner

1140 LUNCH (served in AvK)

1230 Depart for Building 620 via DV Surrey

Building 620 Auditorium

1300 Open Forum with Lab Personnel (to discuss perspectives on workforce issues)

1300 Senior Leadership (Directors, Assoc / Dep Directors, Chief Scientists)

BREAK

1415 Mid-Level Managers and S&Es (Division / Branch Chiefs, Senior S&Es)

1515 Junior S&Es (preferably hired within the past 5 years)

1615 Panel Summary Discussions

1630 Adjourn and Return to VOQ via DV Surrey

6 March 2002

VOQ

0745 Depart for Building 15 via DV Surrey (Check out of VOQ)

Building 15, Arnold-von Karman Conference Room

0800 Continental Breakfast

0815 Panel Caucus

1010 Depart for Building 262 via DV Surrey

Building 262, Commander’s Conference Room

1030 Panel Discussion with Gen Lester Lyles, USAF

1130 Depart for Airport

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Appendix D

List of Presenters and Invited Guests

Presenter/Guest	Affiliation
Dr. Tony Sega	Director, Defense Research and Engineering
Dr. Jim Colvard	Private consultant/ visiting professor Virginia Tech. Former positions include Associate Dir. Johns Hopkins Applied Physics Laboratory; Deputy Director OPM; Deputy Chief of Naval Material Command
Dr. Doug Dwoyer	Director for Research and Technology Competencies, NASA Langley Research Center
RADM Jay Cohen, USN	Chief of Naval Research
VADM Paul Gaffney, USN	President, National Defense University; former Chief of Naval Research
Dr. Rich Roca	Director, Applied Physics Laboratory, Johns Hopkins University
Dr. Mike Andrews	Army S&T Executive
Dr. Anita Jones	Professor of Engineering and Applied Science, University of Virginia; former DDR&E
Dr. Al Romig	VP for S&T/ Partnership & CTO, Sandia National Laboratories
Dr. Bob Foster	Director, Bio Systems, Office of the DDR&E
Dr. Hendrick Ruck	Director, Washington Office, Air Force Research Lab/Associate Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering
Dr. Eric Hartwig	Acting Director of Research, Naval Research Laboratory
Mr. Paul Villela	CEO of Hire @ Strategy, a firm specializing in professional recruitment/hiring strategies
Dr. Tim Coffey	National Defense University/University of Maryland; former Director of Research, Naval Research Laboratory
Dr. Lance Davis	Executive Officer, National Academy of Engineering; former Deputy DDR&E for Lab Management & Technology Transfer
Mr. Walt Morrow	Director Emeritus, MIT Lincoln Lab
Dr. Mike Gibbs	Adjunct Associate Professor of Economics, University of Chicago School of Business; consultant RAND Corporation
Dr. Gretchen Jordan	Economist, DoE, specializing in techniques for evaluating effectiveness of R&D organizations
Dr. Delores Etter	U.S. Naval Academy; former Deputy DDR&E for S&T

Presenter/Guest	Affiliation
Mr. Peter Russell	VP of AON Inc. an international human capital consulting firm
Dr. Robert Whalin	Technical Director, Army Research Laboratory
Ms. Janice Lynch	Personnel Demonstration Project Leader, Office of Naval Research
Ms. Betty Duffield	Head, Human Resources, Naval Research Laboratory
Mr. Dominick Repici	Private consultant
Dr. Hans Mark	University of Texas; former DDR&E
Mr. Frank Cipolla	Management consultant; former Director of Center for Human Resource Management at National Academy of Public Administration; former Director of Personnel Management for DoD
Mr. Jon Etherton	Assistant VP of Legislative Affairs, Aerospace Industries Association; formerly a senior staff member, Senate Armed Services Committee
Ms. Mary Dix	*VP for Administration and Management at the Uniformed Services University of the Health Sciences*
Dr. Howard Risher	Senior Consultant, Fox, Lawson & Associates; Senior Fellow in Wharton's Center for Human Resources
Dr. Brigitte Schay	Director, Assessment Services Division in the Personnel Resources & Development Center, OPM
Dr. Craig Dorman	Office of Naval Research; former Deputy DDR&E for Lab Management
Maj Gen Paul Nielsen, USAF	Commander, Air Force Research Lab
Dr. James Weber	Special Assistant, Air Force Research Lab Executive Director
Ms. Michelle Neuner	Air Force Research Lab; lead personnel demonstration
Gen Lester Lyles, USAF	Commander, Air Force Materiel Command

Appendix E

Selected Bibliography of Studies, Reports, and Briefing Papers Related to Issues Discussed in This Report

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Appendix F

Meeting Agendas *Examples of Unsuccessful NRL Personnel Demonstration Project Proposals*

The examples included in the following table are typical of the kinds of proposals made by the other participating Service laboratories and centers.

INITIATIVE	SHORT DESCRIPTION
Single Integrated Pay Schedule (IPS) extending from GS-1, step 1 to Executive Level III	Provide a compensation system that enables NRL to provide salaries to all employees that are both equitable and consistent with the R&D market place. Salaries would range from GS-1 through Executive Level III. This was not approved due to DoD's and OPM's requirement that the demo projects be relatively cost neutral; DoD/OPM would allow pay only to the ES-4 level. This would require a statutory change to Title V.
Market-sensitive salary ranges within the single IPS	Provide ability to pay defined occupations or occupational grouping a fair and equitable market-based compensation; allow greater ability to react to supply and demand; more competitive, flexible, and economical approach to attracting and retaining highly productive workforce. This could not be accomplished under the DoD's requirement that the demo project be relatively cost neutral.
Management by NRL of ST positions	Management of these positions within allocations established by higher authority so that NRL would have the flexibility to adapt quickly to changing requirements and to recognize deserving managers and scientists. This could not be accomplished under Navy's and DoD's preference for review and control of these positions.
Management by NRL of Senior Executive Service (SES) positions	Manage SES positions within overall authorized allocations established by higher authority. This could not be accomplished under Navy's and DoD's preference for review and control of these positions.
Classification Appeals	Internal adjudication of appeals. This could not be accomplished due to standard DoD-wide wording for the classification appeal process-first to DoD, secondly to OPM except for S&E Professional Level V positions for which DoD issues final decision.
Reduction in Force (RIF)	Currently, retention order for assignment rights is be based on tenure and RIF Service Computation date. Credit for veterans' preference (10 years for compensable and 5 years for all others) and performance is added to the employee's service computation date. Performance credit is the last to be added. NRL wanted to have contribution credit

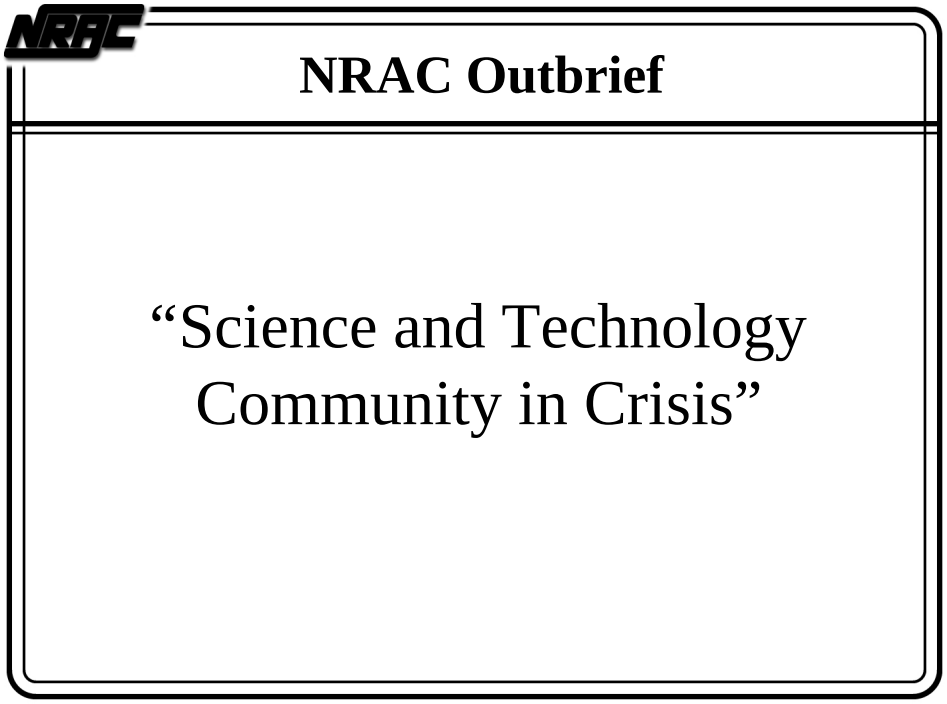
	be the first order of retention under the Demo. Retention order for assignment rights under demo would be based on three factors: RIF Credit Category Score (CCS), Veterans' Preference, and RIF service computation date. The RIF Credit Category would be the primary displacement tool in a RIF action. This could not be accomplished as OPM determined the requested process was a violation of veterans' rights based on original order of RIF preference under Title V. This would require a statutory change to Title V.
Exempt NRL from mandatory PPP use for actions internal to NRL	Allow NRL to correct internal skill imbalances, make workload adjustments, and manage downsizing more effectively. It would eliminate the need for RIF in some cases. Was not approved due to DoD policy that PPP requirements are a corporate interest. Would not allow any demos to establish precedent setting changes.
Direct Appointment Authority for positions for which it is not practicable to hold a competitive examination	NRL wanted to obtain the ability to make immediate job offers for shortage category positions. NRL averages only 1.8 qualified scientist and 1.6 qualified engineer candidates for each vacancy requiring specialized experience. Thus, the required competition does not seem to be practicable since there really is no competition. This would provide much more timely recruitment and hiring actions for hard-to-fill scientific and engineering positions where candidates are very limited in number and in very high demand. This could not be accomplished as it would violate merit principles and veterans' preference provisions in Title 5. A proposed solution would be legislation that would authorize NRL to: design and implement recruitment programs without regard to any provision of Title 5, USC governing the appointment and hiring of personnel into the Civil Service; and appoint, fix the compensation of, and define the duties and authority of scientific, technical, and other professional employees of the Lab.
Eliminate Rating and Ranking of Merit Staffing candidates	NRL requested to eliminate rating and ranking of Merit Staffing candidates when there are fewer than 15 qualified candidates. DoD's position was that the current regulations allowing us to identify and document job-related criteria to distinguish best-qualified candidates from those who meet only minimum qualification requirements provide enough flexibility. The best-qualified candidates could be certified without further rating and ranking. This interpretation still requires a rating process above the minimally qualified decision. NRL has asked for a waiver of DoD's interpretation of the term "relative ability" in 5 USC 2301(a)(1) which mirrors OPM's interpretation in the cancelled FPM Letter 335-17 dated 29 October 1992. Since this has been cancelled, interpretation should be allowed at the activity level.
Promotion of noncitizens without advertising	Allow NRL to promote noncitizens through accretion of duties without advertising. OPM determined this was a violation of the law allowing appointment of noncitizens to competitive positions. There

	may be qualified, available U.S. citizens at the higher level. This would need a statutory change to allow non-competitive promotions if work is in the same specialty field as original appointment.
Experts and Consultants	Delegate authority to NRL to appoint, renew, and extend appointments and to change compensation in the case of experts and consultants. DoD did not approve. It was felt that there was a need for central control to ensure the authority was used correctly.
Movement of temporary employees to different positions	Allow waiver of law to permit NRL to move temporary employees to positions with duties different than those duties of the original position without advertising and giving the employee a new appointment. OPM felt this could cause potential abuse of veterans' preference. They also had problem with ICTAP (an outplacement program) consideration. This would need a statutory change to Title V.
Detail of employees outside DoD	Allow NRL to approve a detail of employee to a position outside DoD. OPM questioned/DoD did not approve. Reason: detail not within demonstration project, i.e., demo limited to NRL. NRL is working a 246 waiver for this initiative.
Changing Workforce Program (CWFP)	To permit NRL to offer NRL early retirement or a severance/buy-out benefit to employees who are not contributing comparable to their pay level, under an agreement wherein the employee departs but does not receive a formal removal decision. This early retirement option was deleted because demo projects are not permitted to waive retirement law/regulation. A buy-out option remained in the demo plan until it was reviewed by OPM. OPM staff raised concerns about public image (program may appear to pay off poor performers) and interference with the current buy-out program. They also stated that this program would not pass political scrutiny. This initiative was important to helping NRL use the results of CCS to encourage the departure of low contributors compared to their salaries. We recognize the reluctance to pay off poor performers. However, the result of this reluctance is that the government continues to pay low contributing performers to stay on the rolls because traditional removals and the resulting financial impact on employees are so unpalatable to supervisors. This is particularly true when the employees are hard working and have had many years of loyal service. We recognize that this program may have an impact on the normal buy-out program but we believe it is one that furthers NRL's, and potentially the government's, goals and benefits the taxpayer. It is also reflective of current private industry practice such as that found in the Ford Motor Company's clause to shed low-performing workers through buyouts. (New York Times, July 22, 1998). If less contributing employees leave under the CWFP, then there could be a reduced need to offer buy-outs or conduct RIFs which impact

	employees who are highly valued. Private industry recognizes the problem of firing poor performers and many offer a buy-out package instead. We felt we should emulate this approach. Without the CWFP, NRL will be required to force fit these situations into either the RIF or performance-based action arenas if the employees are unwilling to leave.
Appointment of Retired Armed Forces Members	Delegate to NRL approval authority for appointment of retired members of the armed forces within 180 days of retirement. ODASN (CP/EEO) did not approve. They felt there were no savings in timeliness. NRL is requesting DoD to delegate this authority to the NRL Technical Director.
Include Locality Pay in Merit Increase Pool	Locality pay was implemented under the Federal Employees' Pay Comparability Act of 1990 which inferred that all employees would receive this pay. OPM did not want NRL to include the locality pay in its merit increase pool because this did not "guarantee" that all employees would receive the locality pay.

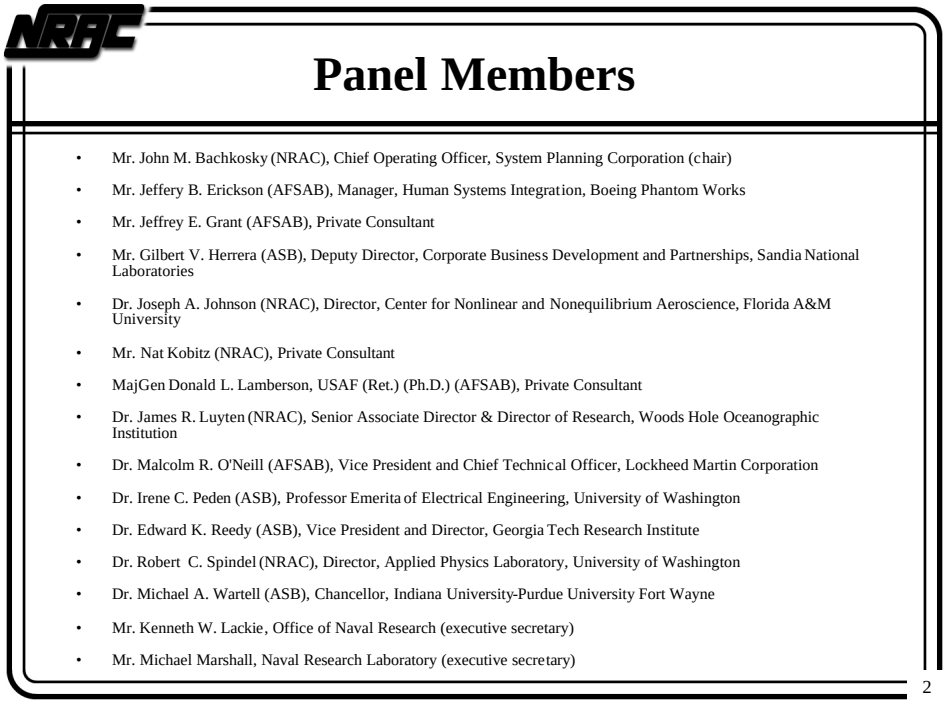
Appendix G

Power Point Brief With Notes



SCIENCE & TECHNOLOGY COMMUNITY IN CRISIS

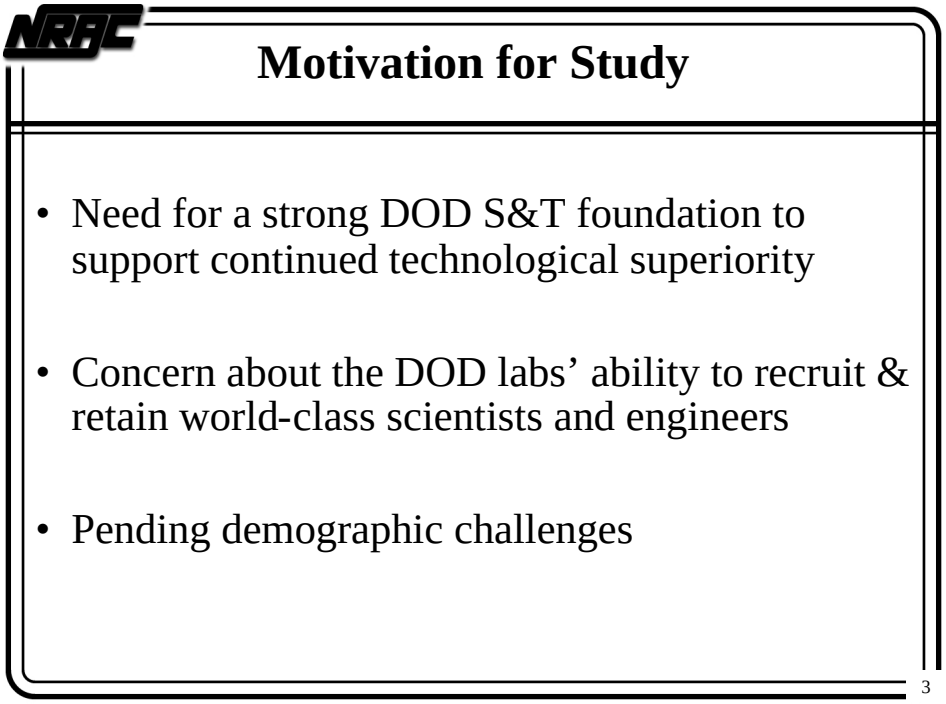
Study conducted under auspices of Naval Research Advisory Committee and sponsored by the Director Defense Research and Engineering
Five meetings: Oct 01, Dec 01, Jan 02, Feb 02, Mar 02, including on-site visits to three Service corporate research labs: Naval Research Lab, Army Research Lab, Air Force Research Lab
At each lab, panel met with groups of senior managers, middle managers, and recent hires/post-docs



Panel Members

Study carried out by panel composed of members from Naval Research Advisory Committee, Army Science Board, Air Force Scientific Advisory Board

Chaired by Navy and supported by NRAC staff

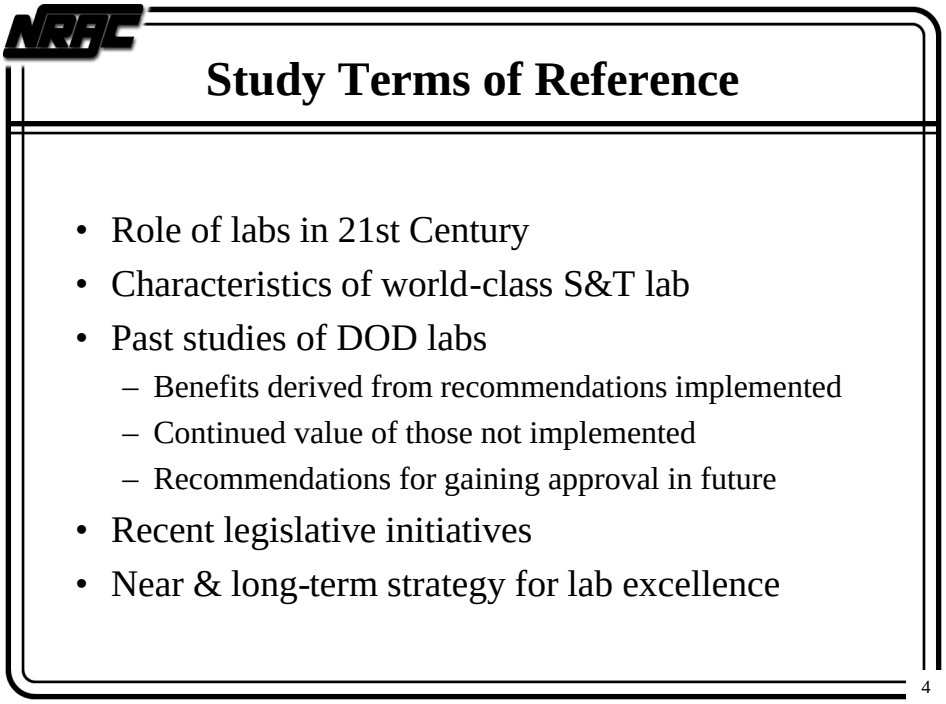


MOTIVATION FOR STUDY

Questions regarding need for and role of DoD labs in the future

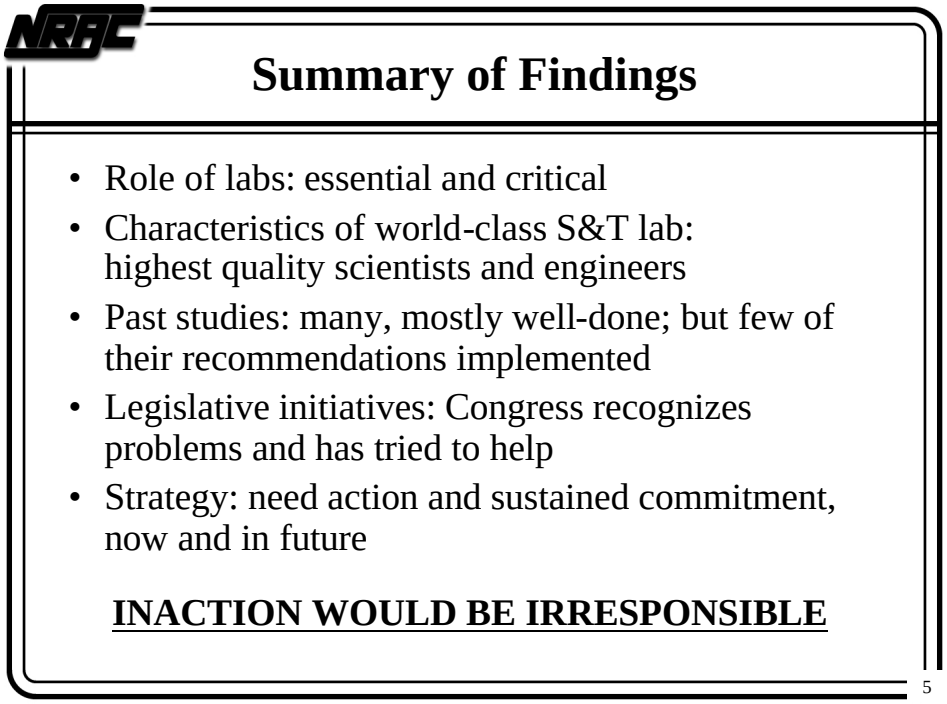
Competition for high-quality engineers and scientists has become intense
- Unable to match industry offers: salaries, stock options, benefits, . . .
- Perception of government employees as second class . . .
- Facilities range from excellent to antiquated
- Burdened by bureaucratic rules and regulations (hiring, financial management, procurement)

Workforce is aging/few young S&Es -- pipeline is not adequate
- Number of US citizens enrolling and graduating with degrees in S&E is declining, especially at PhD level



TERMS OF REFERENCE

The TOR recognized that this area had been studied many times before by distinguished panels, so it focused on reviewing the conclusions of these past studies and updating their recommendations to accommodate 21st Century conditions and challenges.



SUMMARY OF FINDINGS

Role of labs:

- Industry has cut investment in militarily relevant S&T
- At the same time, diversity of future threat increasing--ranges from sophisticated "Axis of Evil" to independent terrorist cells; from ICBMs to chemical & biological agents.
- Industry will pursue high-profit major weapons systems -- labs are crucial to address high-risk, low-volume S&T like that that enabled thermobaric bomb, Predator, robotic countermine systems, and countless others.
- Focus on defense-unique technologies: ability to see inside buildings & caves; remotely detect & identify threats; neutralize mines & chemical & biological agents.
- As technological sophistication of defense systems continues to increase, so does the requirement for in-house technical experts who can advise acquisition PMs on feasibility, affordability, etc.

Characteristics:

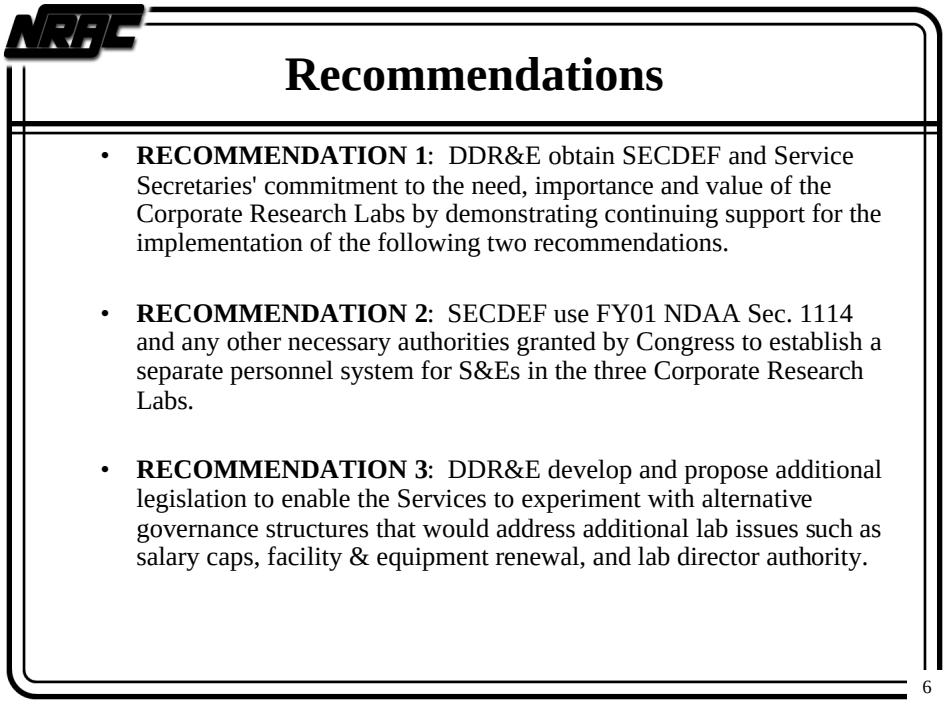
- Highest quality staff -- smart, creative, challenged, dedicated S&Es
- Strong imaginative, creative leadership---who have the authority to make decisions and act
- Adequate facilities and equipment
- Good support services responsive to lab needs

Past studies: More than 100 studies in past 30 years -- generally endorsed requirement for world-class in-house labs, and made remarkably consistent recommendations for reforms. Nevertheless, few reforms were implemented. The most recent DSB studies assumed *a priori* that the Federal "system" can't be fixed, and therefore recommended staffing the labs with contingent personnel or converting them to alternative governance

systems, e.g. GOCOs. While an option that should be considered, it is felt that there are others that may really solve all the problems identified. It is considered imperative that the DoD and Service leadership recognize the unique requirements confronting the labs and implement real reforms to address them.

Legislative initiatives: Congress has repeatedly given DOD the tools to fix the problems confronting the labs, but without a high-level commitment to apply these tools aggressively, most languish unused. Without guidance from above, the "system" tends to take the most conservative approach possible.

Strategy: Must make maximum use of Sec. 1114 authority, and also develop/propose additional legislation to address remaining issues, and do both as quickly as possible.

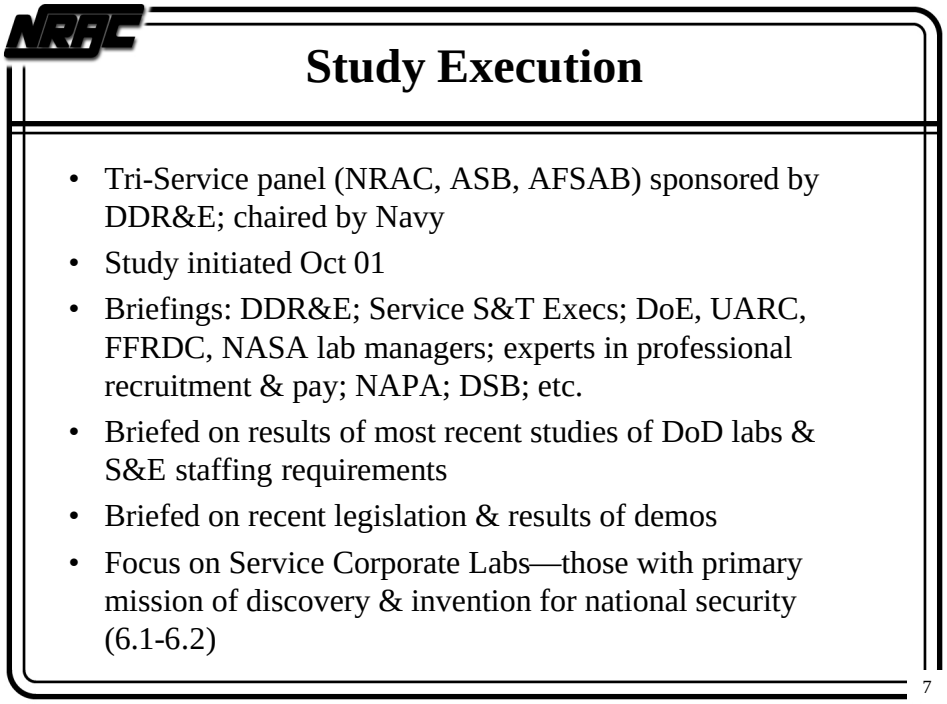


RECOMMENDATIONS

Recommendation 1: Commitment at the highest possible levels is essential to preserve the critically needed S&E staffs in the DOD research labs. The panel focused on the corporate research labs because they are the primary source of discovery and invention -- without new breakthroughs in science and engineering, there will be no advances in such critical defense areas as sensors, weapons, and propulsion. There are no commercial or industrial requirements to locate mines or submarines or to see into mountain caves -- so industry will not invest in such high-risk, low-profit areas. Nor are universities likely to fill this gap because of reluctance to get involved with classified work, make necessary investments in equipment and facilities, etc. The important role of the DoD labs must be recognized and endorsed by the senior leadership of the DOD and Services -- to do otherwise is to guarantee future failure.

Recommendation 2: Congress has recognized the criticality of this issue and in FY 01 NDAA Sec 1114 provided SECDEF with OPM's authorities for personnel demos in the DOD labs. Let's use what has already been given to us -- or OPM will (as they are trying to do) get this authority rescinded. This is an opportunity that must be acted upon now! It is an immediately available stopgap measure.

Recommendation 3: Develop and propose legislation to really address the issues confronting the labs -- salary caps, burdensome procedures, inability to renew facilities and equipment, lack of lab director's authority, poor support services.



STUDY EXECUTION

Met 6 times, visited to NRL, ARL, AFRL – met with senior and middle managers, new hires and post docs.

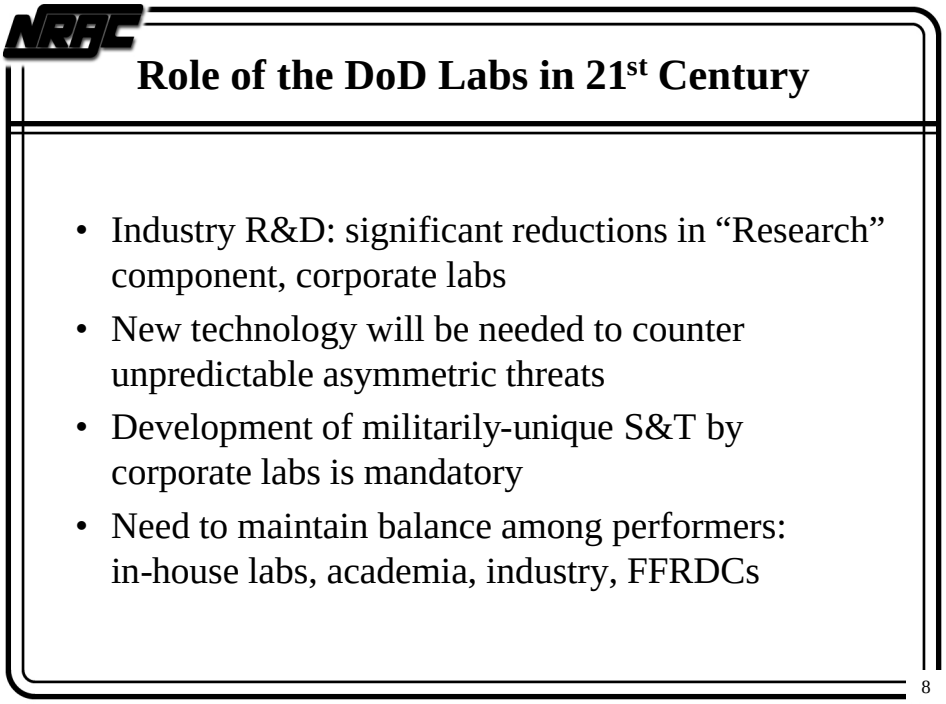
Demo results – positive but not sufficient; good, but many shortfalls – need to leverage and move forward.

Only considered labs doing Basic and Applied Research – those devoted to developing milestone technologies like the atomic clocks that permitted development of GPS and the radar-absorbing materials of key importance to stealth technologies.

Not an overstatement to say their continued excellence is critical to the continued long-term technological superiority of US war-fighting systems.

They have a long history of truly significant developments in militarily relevant science and technology.

They are a small enough and specialized enough community to experiment on new initiatives.



ROLE OF THE DOD LABS IN THE 21st CENTURY

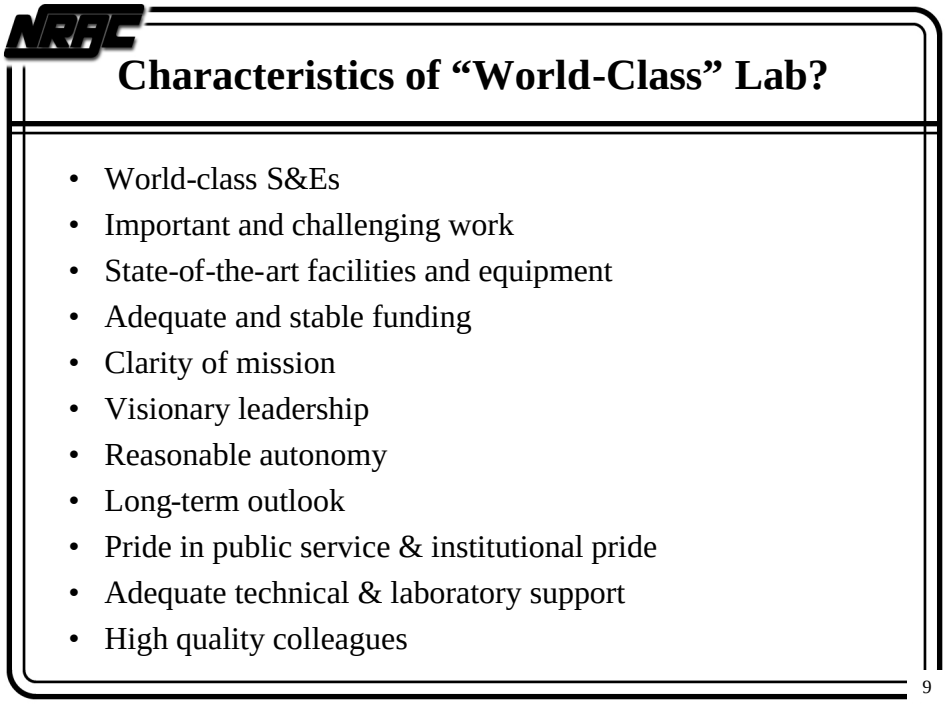
Reductions in industry investment driven by consolidations, changes in IR&D relevance, short-time line to profitability, aversion to risk.

It can take 20 years or more for fundamental research to yield a fieldable technology or system. Length of research pipeline is not well appreciated; in addition, there is no way to reliably check on progress.

Compelling need for broad-based research effort that exploits technology so that we have basis for developing responses. Demand is contrary to both industry motivation for early profits and unpredictable market (may never materialize), and academic focus on basic research and open publication.

There is no recognizable and acceptable alternative to the corporate research labs to initiate and sustain the S&T needed to ensure an effective military against an unknown and unpredictable threat.

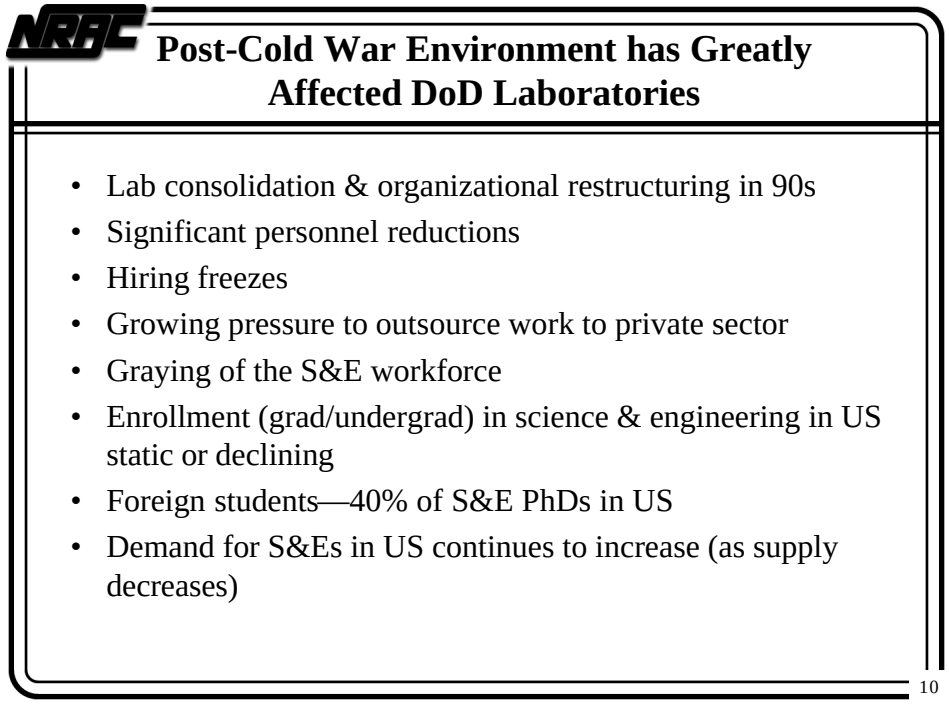
World-class S&Es at in-house labs are an essential ingredient in maintaining a balanced S&T portfolio -- cannot rely on academia, industry, and FFRDCs alone.



CHARACTERISTICS OF "WORLD-CLASS" LABS

The characteristics of world-class laboratories have been amply documented in a large library of DSB, NRC, etc studies over the past 40 years.

A very significant percentage of the breakthrough technologies of the past 50 years came from a relatively short list of world-class labs (BTL, DuPont, IBM, NRL, 3M, pharmaceutical companies) having most or all of these features.



LAB ENVIRONMENT HAS UNDERGONE RAPID CHANGE IN LAST DECADE

Consolidations, downsizing, and hiring freezes over past 15 years prevented renewal of workforce.

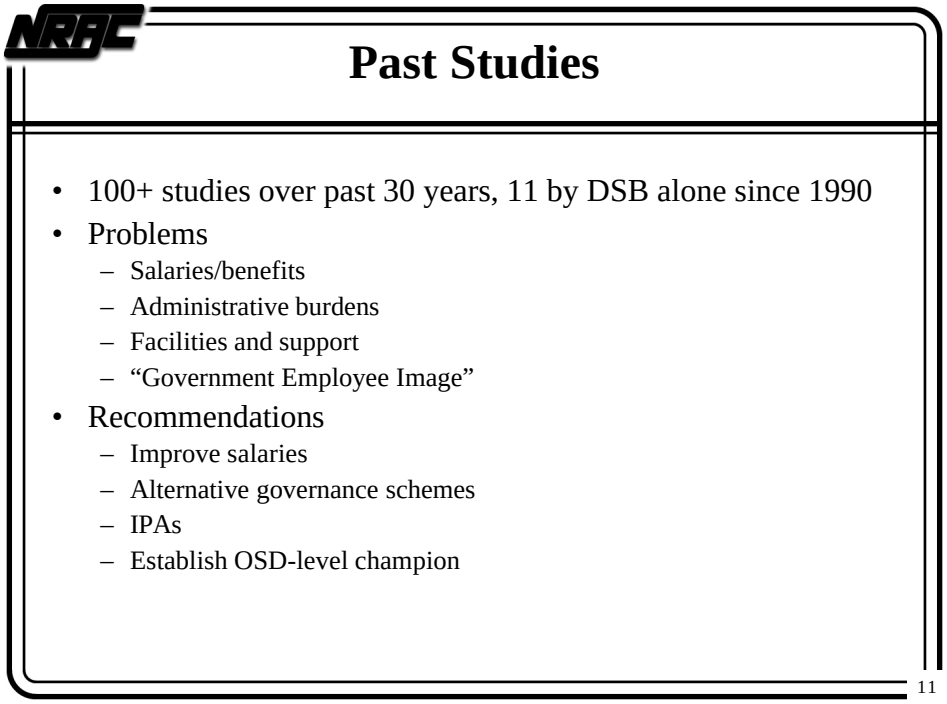
ARL and AFRL created through consolidations of smaller labs in past decade.

Outsourcing to private sector started with building and grounds maintenance and repair, but there now is continuing pressure to outsource more S&T and R&D workyears -- we won't be able to recover if we continue to "outsource" our S&T intellectual capability.

Aging of the lab S&E work force
- >50% are over 50
- 15% are under 35

Large share of PhDs in S&E in US earned by foreign students
- According to NSF *Indicators 2000,* comprise over 40% of all PhDs in S&E in U.S. universities
- Increasingly, foreign-born S&Es returning home to work

Demand for S&Es projected to increase four times faster than overall job growth
- US will need 461,000 more S&Es by 2006
- Research personnel a growing portion of the workforce
- Hi-tech employment up significantly in recent years, more than 21% since '90
- Engineer unemployment currently 1%



PAST STUDIES

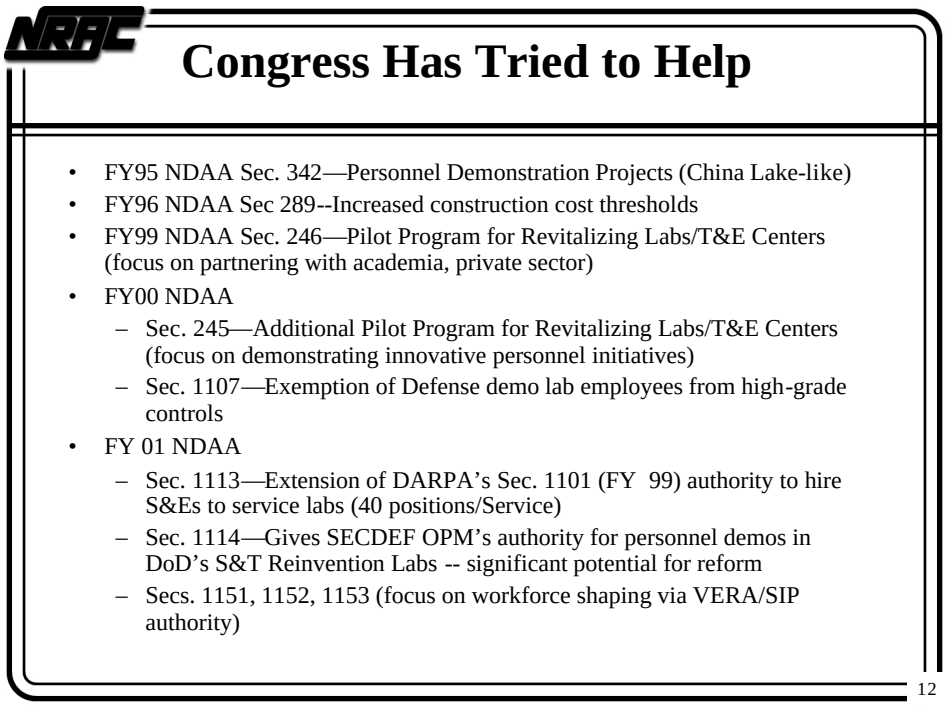
Past studies: More than 100 studies in past 30 years -- generally endorsed requirement for world-class in-house labs, and made most of the same recommendations for reforms.

Principal focus: personnel issues, technical director authority, inability to renew facilities and equipment, quality of support services, technical program balance, technical quality, relevance.

Record shows few recommendations implemented

- Archaic personnel system based on Title 5 (hard to change)
- Lack of understanding by the "system" that world-class labs cannot prosper within stifling array of one-size-fits-all system

After years of studies with no action, several of the most recent DSB studies have recommended staffing the labs with contingent personnel (e.g., IPAs or other loaners) or converting them to alternative governance systems, e.g. GOCOs. These studies assumed *a priori* that the bureaucracy will always be successful in preventing the Federal "system" from being fixed. This is a rather sad commentary on DOD's ability to confront and fix its own problems. Furthermore, the panel believes that such approaches would be halfway measures at best, and would still not really solve the underlying problems confronting the DOD labs.

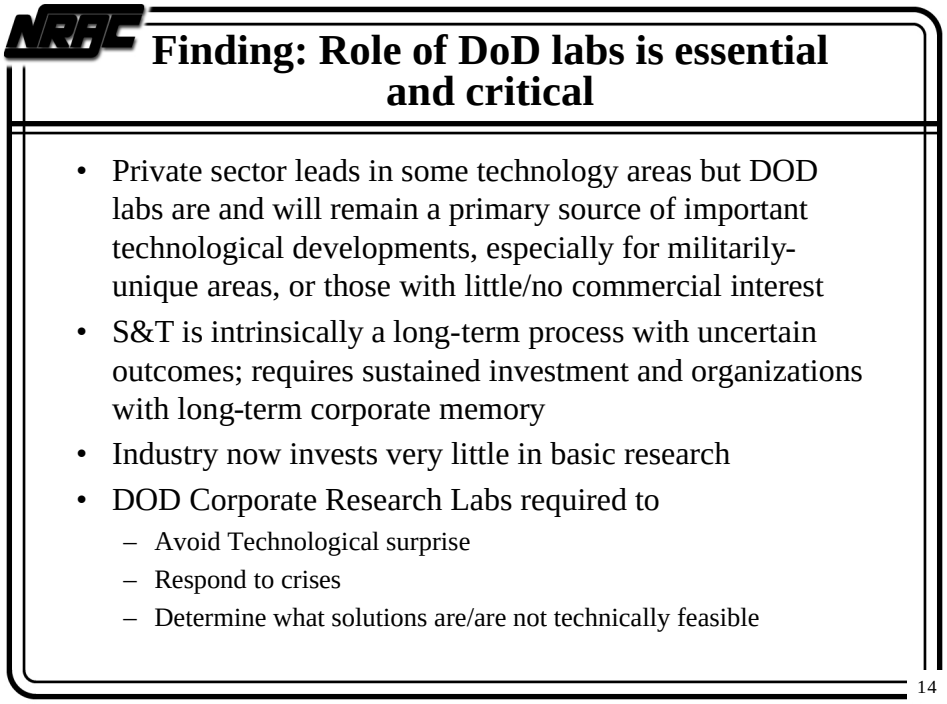


CONGRESS HAS TRIED TO HELP

Congress has recognized the importance of the DOD labs and has provided significant authority to DOD to implement needed reforms.

Significant examples are:

- FY 95 Sec 342 granted authority for China Lake-like personnel demonstration projects at S&T labs; has been the only valuable new tool available in many years.
- FY 96 Sec 289 raised the thresholds for major and minor Military Construction, and permitted labs to build facilities up to $3M without Major MILCON approval.
- FY 99 Sec 246 and FY 00 Sec 245 were intended to permit the labs and T&E centers more flexibility in shaping their workforces and engaging in innovative partnerships with industry; conservative interpretive of its provisions by OSD has prevented much progress.
- FY 01 Sec 1114 attempted (unsuccessfully) to remove the pay cap at S&T demo labs and granted OPM's authority to approve demo provisions to the SECDEF; has not been implemented.



FINDING: ROLE OF DOD LABS IS ESSENTIAL AND CRITICAL

Industry will not invest their resources in high-risk, low-profit endeavors (ASW, DEW, countermine).

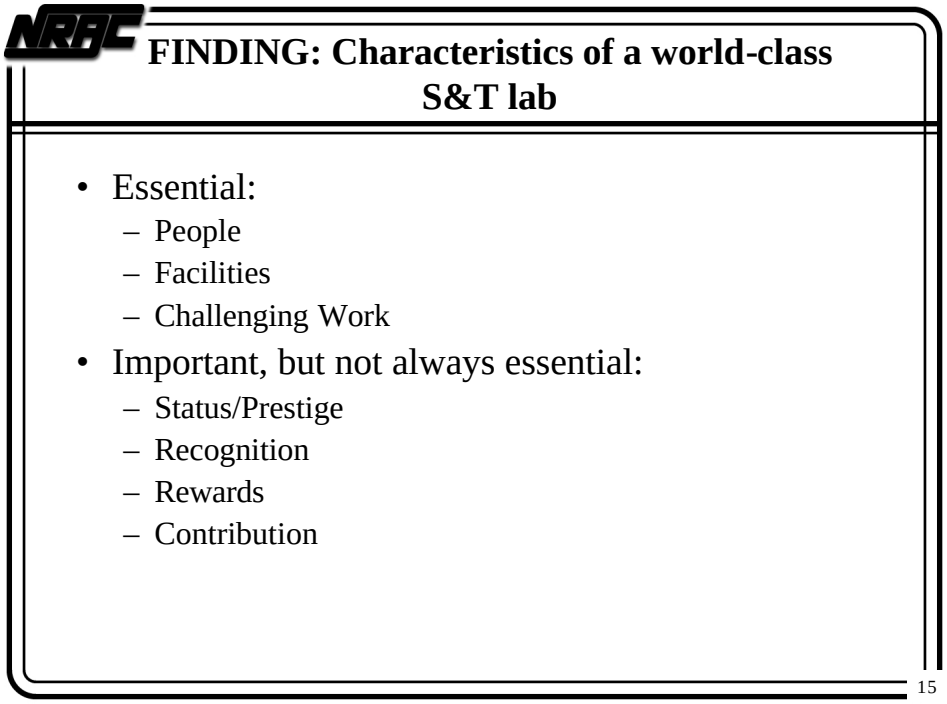
Most of the revolutionary high-tech systems used in Balkans and Afghanistan are products of DOD S&T investments in the 1970s and 80s.

Universities reluctant to participate in important defense areas because classification constraints preclude publishing and recognition.

Industry investment in basic research has and continues to decline – most breakthroughs in military technologies come from DoD research labs (GPS, stealth, thermobaric bomb, sensors, armor, submarine materials, etc).

Although the roles of the labs continue to evolve, many remain critical, some unique:

- Avoid technological surprise and ensure technological innovation
- Respond rapidly in time of urgent need or national crisis.
- Act as principal agents in maintaining the technology base
- Serve as intellectual partner in national R&D enterprise
- Infuse the art of the possible into military planning
- Determine what can and cannot be DONe
- Support the acquisition process
- Provide special-purpose facilities not practical for the private sector
- Be a constructive adviser for DOD directions & programs based on technical expertise
- Support the user in the application of emerging technology and introduction of new systems
- Translate user needs into technology requirements for industry
- Serve as S&T training ground for civilian and military acquisition personnel



FINDING: CHARACTERISTICS OF A WORLD-CLASS S&T LAB

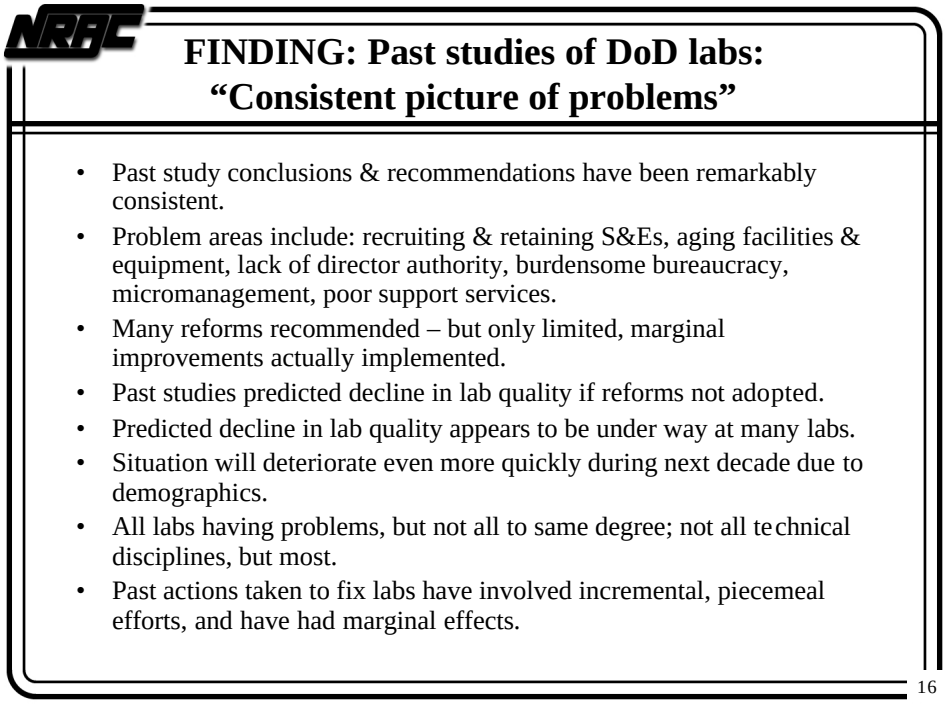
The characteristics of world-class research labs are well known and have been well documented.

Best pharmaceutical, IT, industry labs like Skunk Works, Phantom Works, Pfizer, old BTL have these characteristics.

NRL has long been regarded as a world-class lab, and both ARL and AFRL have been improving in stature since their creation in the last decade.

Score card on the characteristics of the DOD corporate labs:

- People – generally very good, but many eligible to leave soon
- Facilities -- marginal, a mixture of excellent and archaic
- Challenging work – absolutely
- Contribution – yes
- Recognition, rewards, status & prestige – generally, no



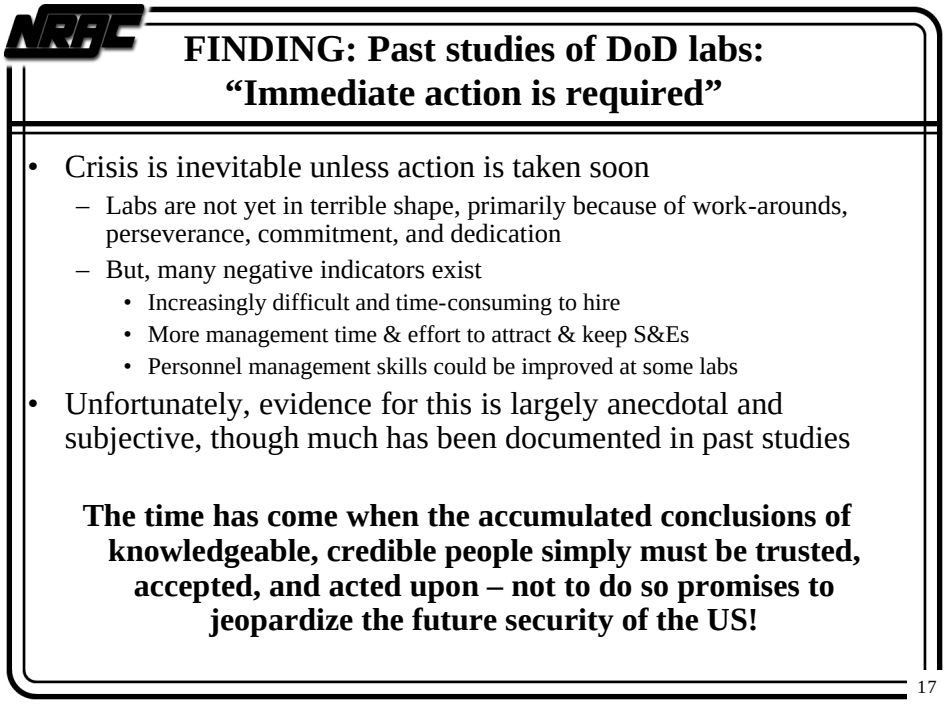
FINDING: CONSISTENT PICTURE OF PROBLEMS

Common Problems Identified

- Salaries/benefits for top S&Es well below industry & academia
- Excessive administrative burdens and micromanagement
- Budget adequacy/instability
- Aging/substandard facilities
- Erosion of pride in public service

Proposed Solutions

- Modify Civil Service system to improve workforce shaping (hiring/firing/downgrading)
- Increase pay (variety of mechanisms proposed)
- Give lab directors more authority
- Alternative governance schemes, e.g. GOCO
- Obtain staff from academia, industry, UARCs, FFRDCs
- Create OSD-level champion



FINDING: IMMEDIATE ACTION IS REQUIRED

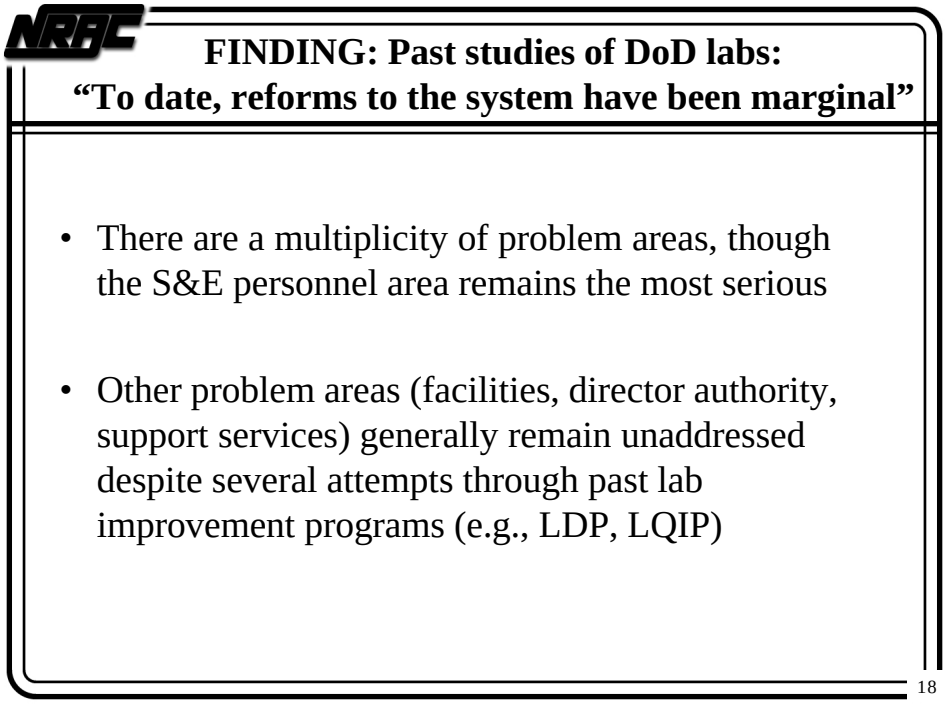
Although the DOD labs are still quality research institutions, many indicators are negative and all report increasing difficulty in performing their unique missions under the burden of a multiplicity of bureaucratic travails.

Most serious problems relate to Title 5 civilian personnel system, but others present serious impediments to world-class research.

Single reform package:

- Could make headway on all problems
- May also be easier to obtain endorsement of DoD/Service leadership and permit follow-through on their watch
- Less likely to be opposed by stake-holders in OSD, OPM, etc.
- May be easier to include flexibility to accommodate Service differences

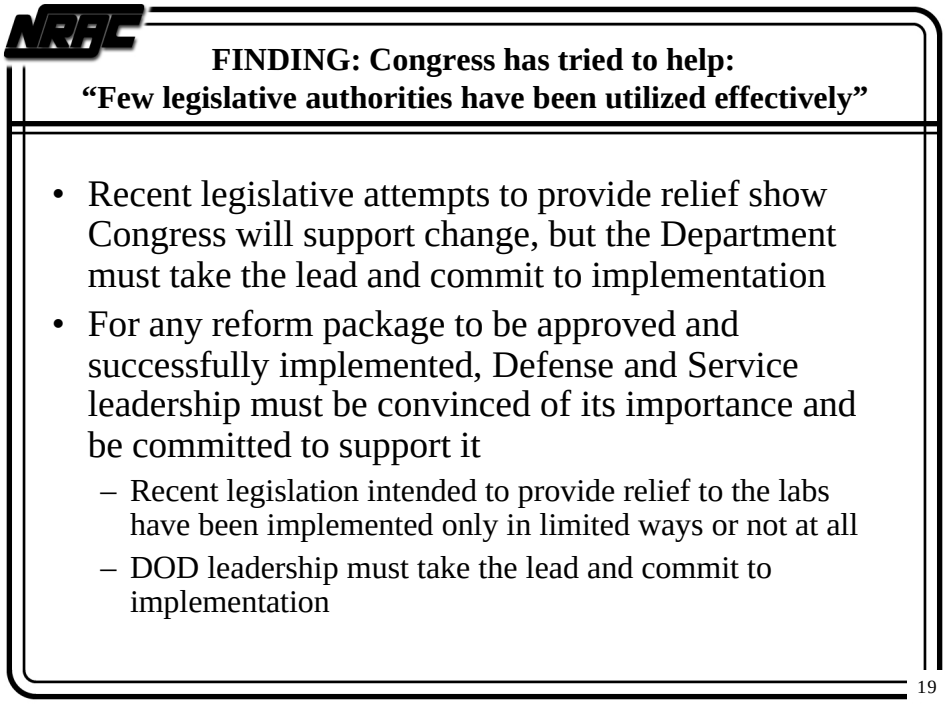
Current lab S&Es may be in best position to articulate the unique strengths of their labs for outreach, recruiting, and retention.



FINDING: REFORMS TO THE SYSTEM HAVE BEEN MARGINAL TO DATE

Over the past 15 years, several large, well-documented programs (Laboratory Demonstration Program, National Performance Review, Laboratory Quality Improvement Program) have attempted to implement many of the reforms identified by previous studies. Despite thousands of work-hours of effort, these programs have generally produced no meaningful changes to the existing system.

The most ambitious of these programs was the LDP, established by DOD in response to a prescient 1987 DSB report. Despite a series of specific written directives by the DEPSECDEF, the OSD and Service staff offices have not taken any meaningful action to implement the more than 50 lab-related initiatives, and most of the problems identified by the 1987 DSB panel remain unaddressed.



FINDING: FEW LEGISLATIVE AUTHORITIES HAVE BEEN UTILIZED EFFECTIVELY

Even when granted specific statutory authority, changes to the existing system have been modest at best.

Many of the most innovative initiatives proposed by the Sec. 342 personnel demo labs were disapproved by OPM or OSD.

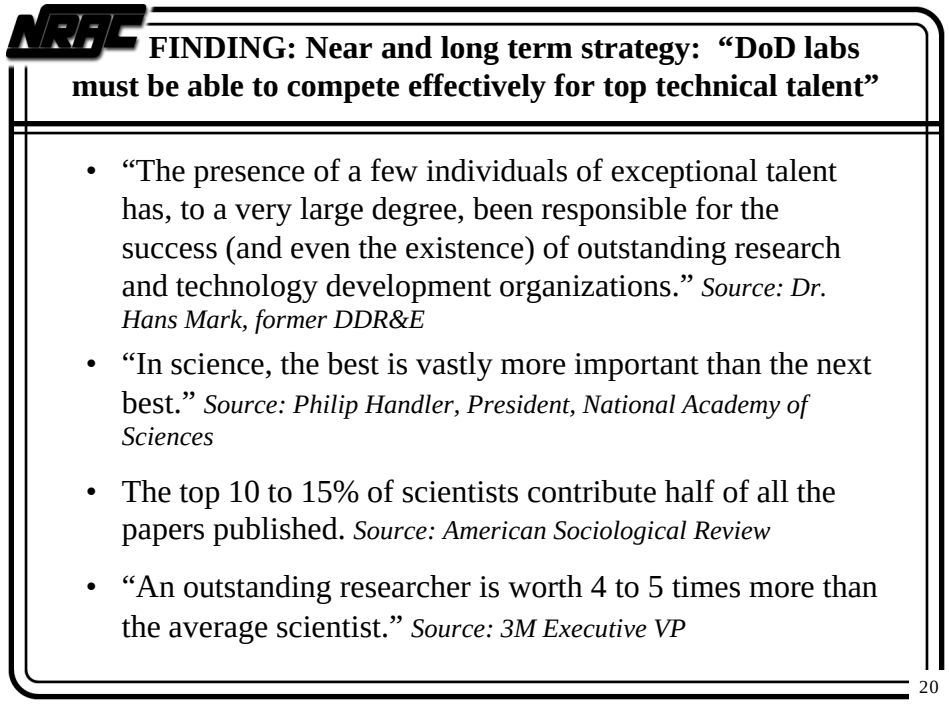
"Solutions" to lab problems to date have primarily consisted of incremental "demonstration/pilot" approaches (patches and fixes to Title 5), and piecemeal legislative efforts

- Result is a personnel system that approaches the IRS tax code in complexity
- System is so convoluted that almost any action can be undertaken legally, and just as easily opposed legally
- Effects are most onerous at labs that recruit mostly PhDs, i.e. NRL, ARL, AFRL

The Sec 342 demo projects are not really being used by the labs as demos, but as the only available partial fixes to critical problems

- True demonstrations should be more radical in nature but more limited in coverage

Patches no longer work-the time for responsible action is now!

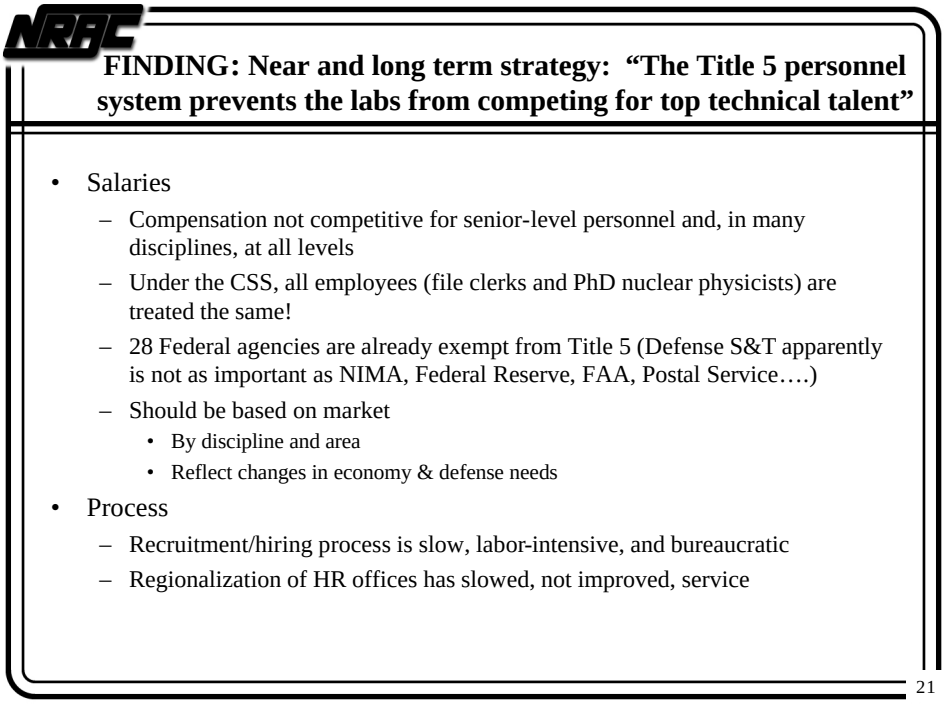


FINDING: DOD LABS MUST BE ABLE TO COMPETE EFFECTIVELY FOR TOP TALENT

The real issue is not whether the labs can muddle through under the current system and fill S&E vacancies with entry-level personnel -- it is whether they can compete effectively for the top 10% of both entry-level and PhD-level scientists and engineers. These are the people who will drive the quality of the science and technology programs at the labs in the future.

Those that defend the current Title 5 personnel system as being "good enough" often point out that DOD-wide data do not prove that the labs have a problem recruiting and hiring S&Es. However, such average data generally include many non-S&T organizations and personnel.

"In most personnel matters events are measured in averages…the averages serve the purposes of the insurance companies, but they are meaningless, indeed misleading, for personnel management decisions." Source: Peter Drucker



FINDING: THE TITLE 5 PERSONNEL SYSTEM PREVENTS THE LABS FROM COMPETING FOR TOP TECHNICAL TALENT

A 1999 study carried out professor Howard Risher of Wharton, as part of OPM S&T personnel demonstration, shows:

- Salaries paid to engineers in commercial R&D sector are among the highest
  - Exceeded only by those paid in chemical, drugs, plastics sector
  - True across full distribution of salaries, including those for new engineers
- At the 90th percentile, Federal salaries are lower than those in industry for all sectors
- The most serious problem confronting the Federal Government is low salaries
- Gap in starting salaries is substantial
- Management & supervisory salaries are a particular concern for the Federal Government

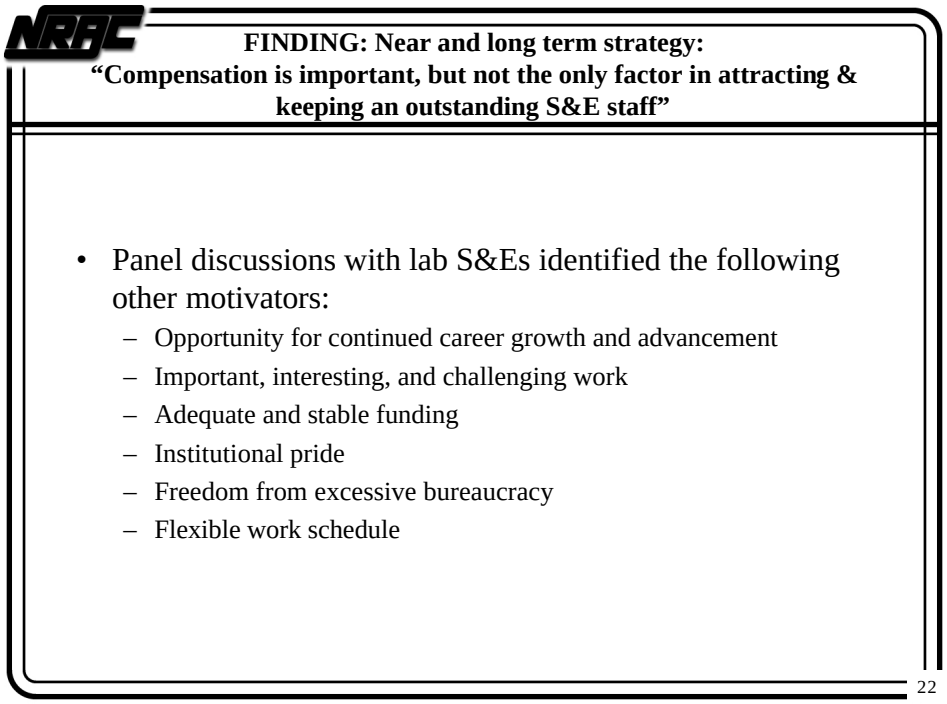
Virtually every study of the DOD labs has concluded that the Title 5 Civil Service System is not responsive to the needs of the DOD labs. The most recent studies have concluded that Title 5 can never be made to work for the labs. In 2000, the NAPA studied the civilian personnel problems confronting the entire Department of the Navy and concluded that Title 5 was hopelessly out of date and that a whole new personnel system was required.

Demos and incremental fixes may already have provided about as much as can be expected, and additional fixes to Title 5 are probably not worth the effort.

Compensation must be competitive

- Example: the salary of the Director of NRL, an $800M/yr laboratory, is $133,000 – far below comparable positions in industry and academia, even those with much less demanding responsibilities.

- Inadequate compensation is now posing a major impediment to maintaining DoD lab excellence.
- Must allow for reasonable quality of life for highly sought-after S&Es.
- Bottom line – compensation is inadequate to attract the required talent.

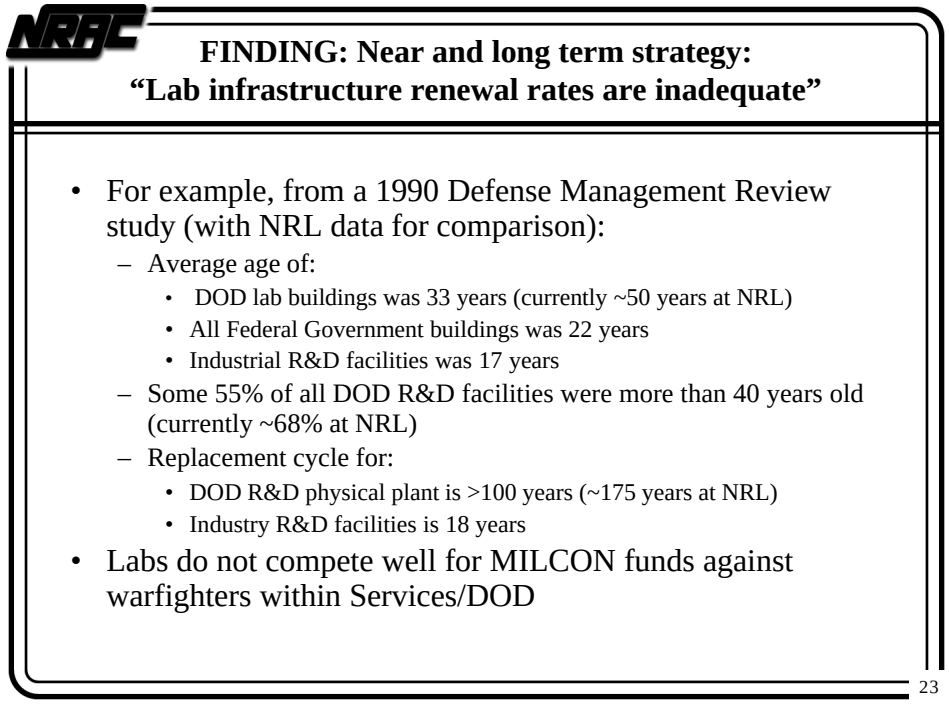


FINDING: COMPENSATION IS IMPORTANT, BUT NOT THE ONLY FACTOR IN ATTRACTING AND KEEPING AN OUTSTANDING S&E STAFF

Not all S&Es are motivated by the same things, but the list of primary attractors is relatively short. Most of the recruiting successes the DOD labs have had in recent years can be attributed to the fact that they still offer interesting, challenging research projects and will support such research work over the long term as long as it offers the promise of enhancing the performance of defense systems.

Future recruitment efforts would be enhanced if based on a better understanding of what motivates today's young PhDs in science and engineering.

There may be value in chartering a continuing effort to survey recent graduates in fields of interest.



FINDING: LAB INFRASTRUCTURE RENEWAL RATES ARE INADEQUATE

Many previous studies have noted that funding for Federal R&D facilities is inadequate, with the DOD labs among the worst.

In 1991, DOD backlog of unfunded repairs to research facilities was $850M. Little progress has been made in reducing this backlog since then.

In 1993 study, GAO stated many Federal lab facilities could not be upgraded to meet current R&D requirements, and recommended demolition and new construction.

Laboratory buildings often cost 3 or 4 times as much per square foot than more conventional structures.

NRC and GSA standard for annual cost of maintenance & repair (M&R) of typical facilities is 2 - 4% of plant replacement value (PRV), not including reduction of backlog of deferred repairs.

During 1990s, Navy invested only 1.6 - 1.9% annually on M&R, and attempted to impose such limits on its labs.

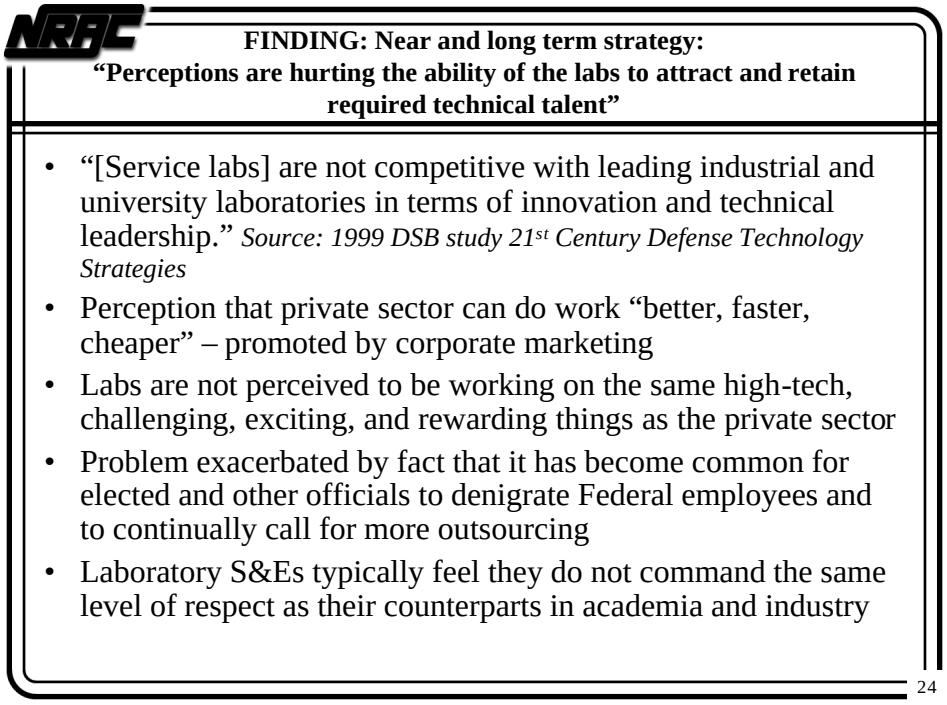
For FY 01, Navy estimated M&R funding of 2.1% of PRV required just to stop growth of backlog.

DOD lab facilities must depend on the appropriation of specific MILCON funds for each building project. Lab facilities are not considered "mission critical" infrastructure by the Services and DOD and do not compete well for such funds against such projects as runways and child-care centers.

In addition, MILCON funds are highly prized on Capitol Hill, again placing many labs at a competitive disadvantage.

Specific legislation would be required to break the link between MILCON funds and lab facility construction.

Although MILCON funds are not required for scientific equipment, complex financial regulations often prevent the laboratories from being able to procure state-of-the-art equipment.



FINDING: PERCEPTIONS ARE HURTING THE ABILITY OF THE LABS TO ATTRACT AND RETAIN REQUIRED TECHNICAL TALENT

"Because it has become fashionable to denigrate Federal employees and Government jobs often pay less than those in the private sector, the idea of working the Government is a far less attractive option for young college graduates." Source: Government Executive Magazine (Sep 99)

"…DoD laboratory directors are unable to obtain or retain the services of not only the "best and brightest" scientists and engineers but even those of average quality." Source: DSB study on DoD Science & Technology Funding (Jun 00)

"The image [of public service] does not sit well with my graduate students who would like to go into government, but are concerned about the image." Source: Rosslyn Kleeman, GWU Department of Public Administration

A 1998 survey for Pew Charitable Trusts and National Association of Public Affairs and Administration found that Phi Beta Kappa honor society members generally have unfavorable views of government careers.

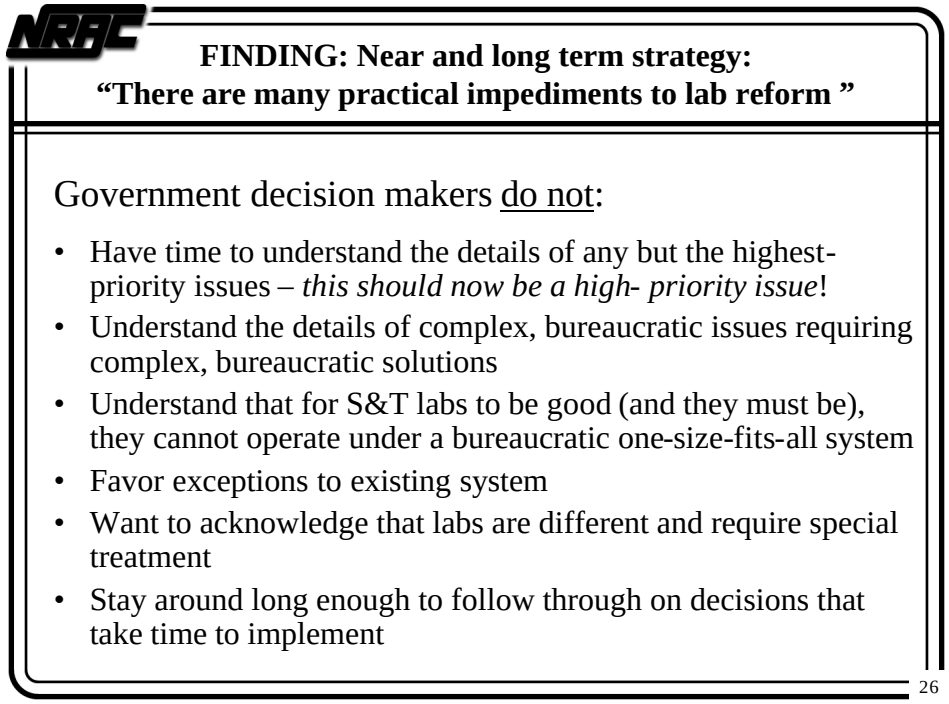
"Overall, the allure of public service has faded." Source: DSB Task Force on Human Resources Strategy (Feb 00)

FINDING: IMPEDIMENTS TO LAB REFORM

DOD laboratory director authority has been undergoing significant and sustained erosion
- Do not have hire/fire authority
- Lack authority over basic support services, e.g. HR, public works, finance/accounting, travel, etc.
- Limited in ability to procure equipment, renew facilities, transfer personnel, etc.

OSD and Service staff offices (OGC, comptroller, HR) tend to treat all organizations in the same way, and strenuously resist any exceptions to the existing system. Even authorities specifically granted by Congress tend to be interpreted conservatively and implemented only after great deliberation.

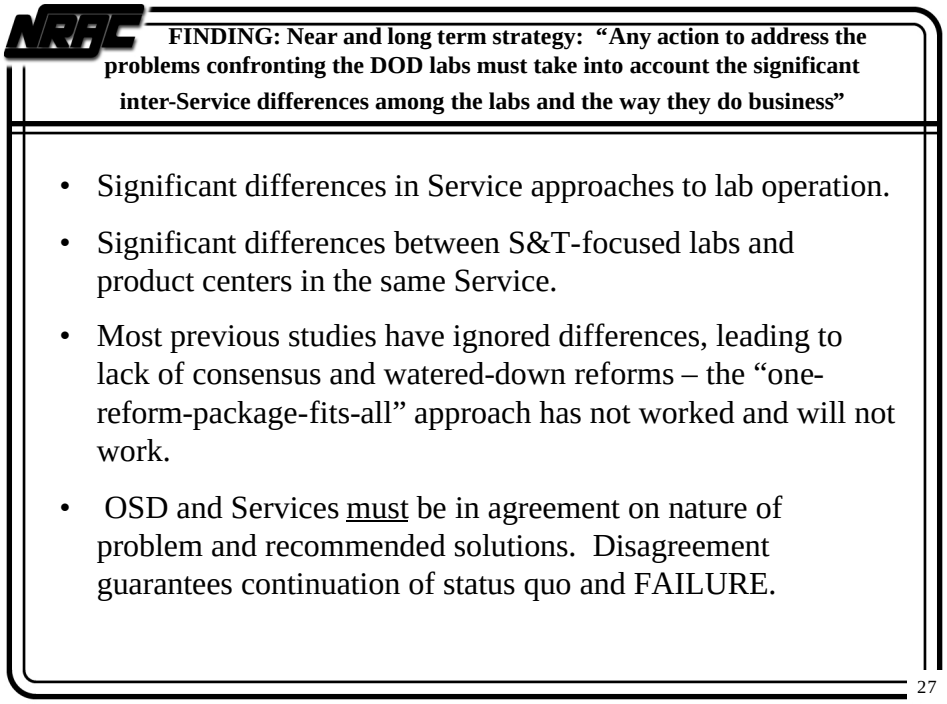
Not a question of good vs. evil; rather, it is the logical behavior of a large bureaucracy that gets its hand slapped whenever anyone in the system makes a mistake.



FINDING: THERE ARE MANY PRACTICAL IMPEDIMENTS TO LAB REFORM

The bureaucracies (OMB, OPM, OSD, Services, HQ commands, etc) tend to be very conservative in outlook and do not readily approve radical reforms that admit that exceptions to generally accepted ground rules must be made. Therefore, the people on top must make an unequivocal commitment to endorse such exceptional reforms and direct their subordinates to assist in implementing them.

Given the short time horizon of most political appointees, any POA&M for addressing the problems confronting the labs must provide for at least a few of the benefits to be realized during their watch.



FINDING: ANY ACTION TO ADDRESS THE PROBLEMS CONFRONTING THE DOD LABS MUST TAKE INTO ACCOUNT THE SIGNIFICANT INTER-SERVICE DIFFERENCES AMONG THE LABS AND THE WAY THEY DO BUSINESS.

A 1991 Congressional Research Service study of the labs put it this way: "comparing the defense laboratories among themselves can be difficult since no two are alike. They differ in the subject areas they focus on, the mix among categories of work (e.g., the proportions of basic, applied, and development activities each perform), and the weighting of their missions among a number of basic tasks. Clearly, the differences among the Services' laboratories make evaluation and comparative analysis difficult to achieve."

Differences between Army/Navy/Air Force labs:

- Funding mechanism (WCF vs appropriated)
  - Ownership/non-ownership of support services
  - Cost to customer of a WY
  - Ownership of PEs
  - Mechanisms used to obtain S&T funds
- Funding mix
- In-house/out-of-house ratios
- Relationship to research program management offices (ONR, ARO, AFOSR)

Differences between S&T labs and product centers:

- S&T Labs predominantly or totally devoted to S&T work (6.1, 6.2, 6.3)
- Product centers predominantly funded by higher categories of R&D (6.4 - 6.7), procurement, O&M, etc
- Labs have much higher percentage of PhDs
- Labs more focused on science; product centers more focused on engineering

– Product centers often do in-service and systems engineering, provide interoperability and software support, and are more likely to perform provide direct technical support to operational commands.
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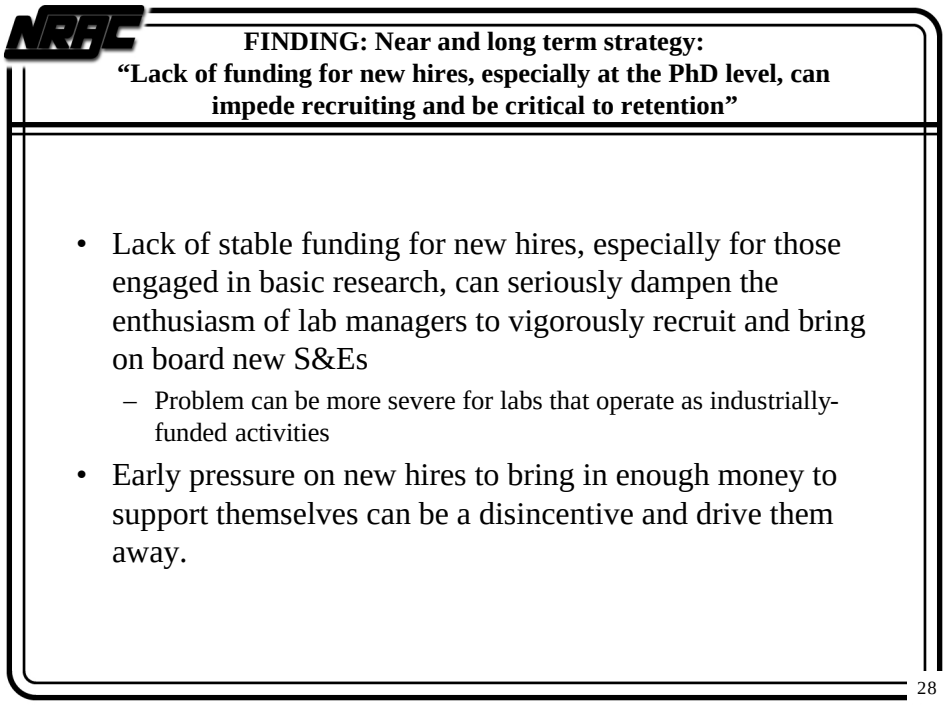


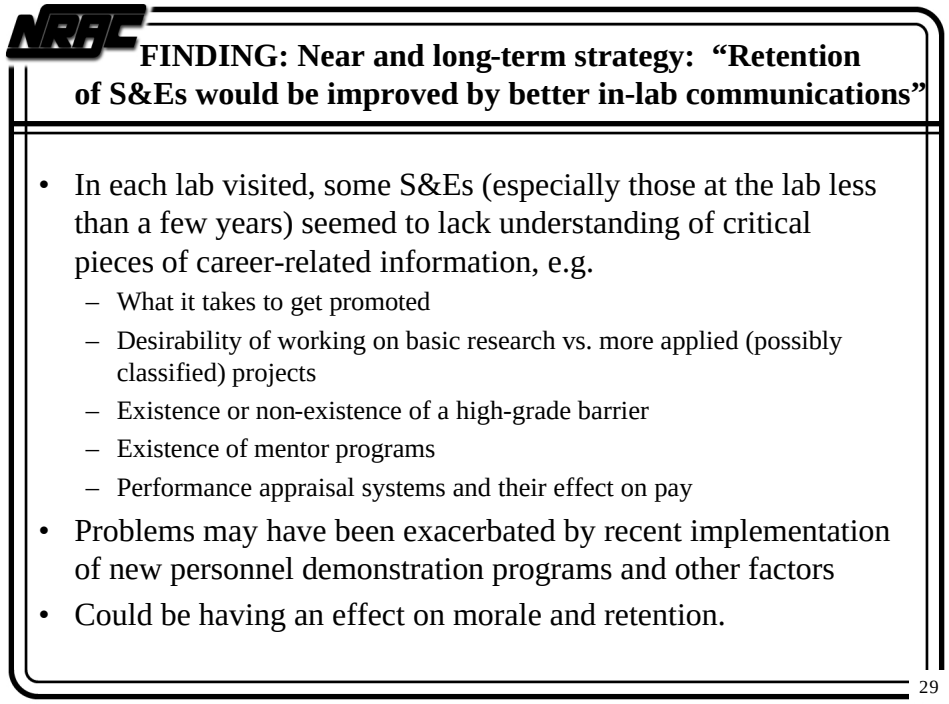
FINDING: LACK OF FUNDING FOR NEW HIRES, ESPECIALLY AT THE THE PhD LEVEL, CAN IMPEDE RECRUITING AND BE CRITICAL TO RETENTION

Turnover is high in the first few years of employment under any circumstances; any effort to reduce it is worthwhile.

There may be value in establishing mechanisms for ensuring (at least) partial support for new S&E hires, especially those working on basic research, for first 1-2 years.

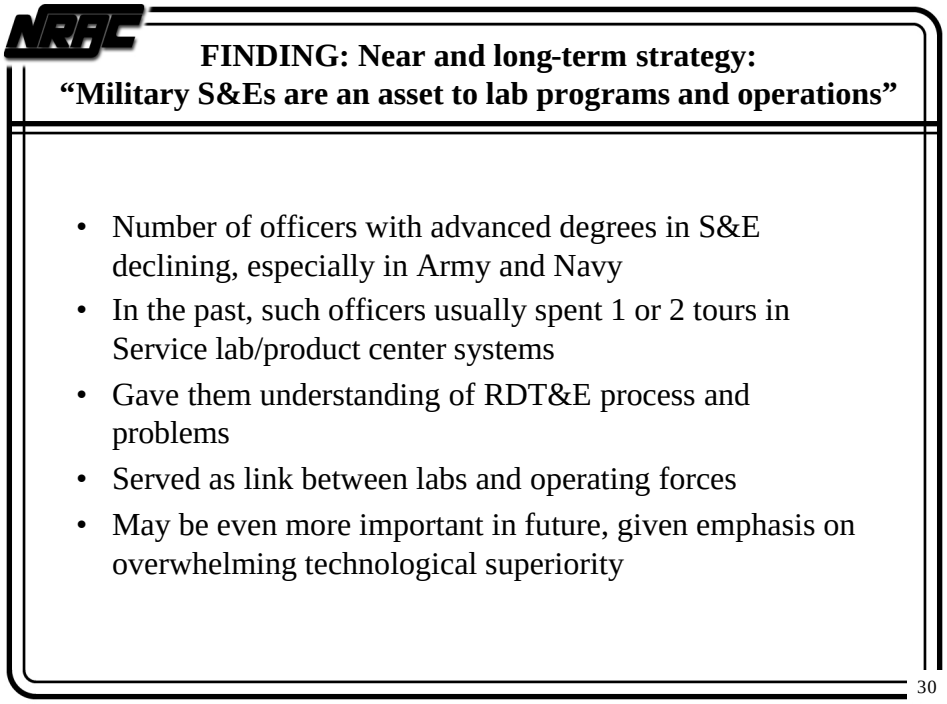
Relieve some pressure on new hires to obtain funding.

Create an environment more attuned to hiring at entry level.



FINDING: RETENTION OF S&ES WOULD HELPED BY BETTER IN-LAB COMMUNICATIONS

In all laboratories, the panel found evidence that communication between senior leadership, middle-level management, and new employees could and should be improved. It is important for Lab Directors to take more aggressive steps to insure proper structuring of lab careers and mentoring of S&T employees.

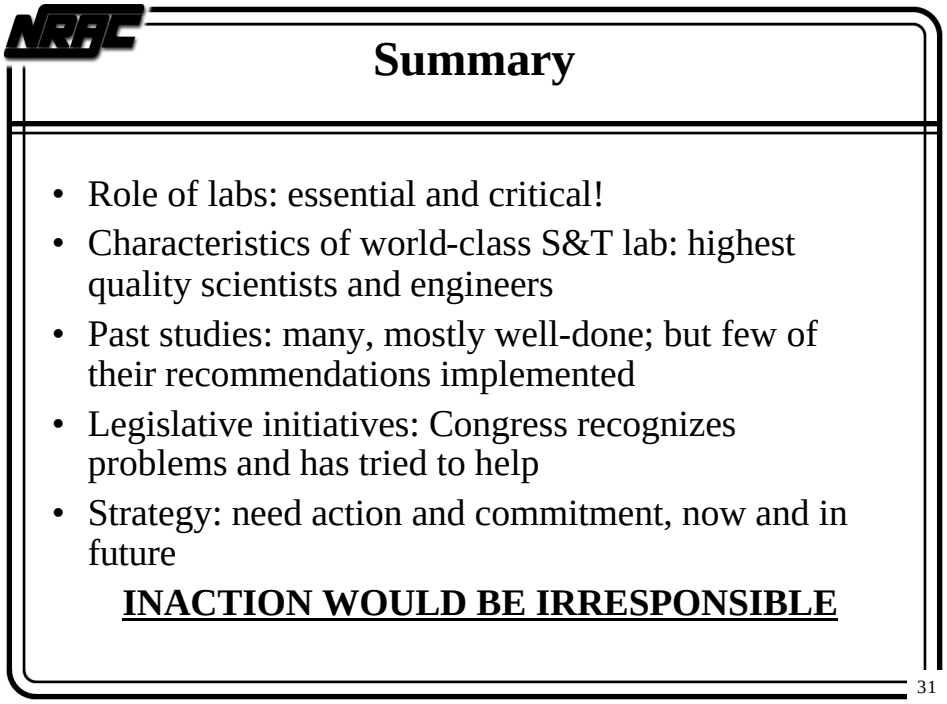


FINDING: MILITARY S&ES ARE AN ASSET TO LAB PROGRAMS AND OPERATIONS

The panel unanimously agreed that the role of uniformed S&Es was very important, and was concerned that the Services were not full exploiting this capability. Although the issue was not thoroughly investigated, the panel believes that the services could improve development, support, and promotion of uniformed S&E personnel to their considerable long-range benefit. Therefore, the panel urges further investigation of this important topic.

A tour in a lab or center should be considered as one of several possible career-enhancing (rather than the opposite) assignments available to a junior officer, no matter what his/her background and specialty.

An understanding of how new war-fighting technologies and systems are developed is certainly as important as understanding the intricacies of the POM process.



SUMMARY

This study did not need to break any new ground -- this subject area has been adequately investigated by a long series of blue-ribbon panels in the past.

The findings and recommendations from most of these studies have been overwhelmingly consistent -- the labs are an essential component of our high-technology war-fighting machine, and they will soon be unable to do their jobs if they DON't get some help at the Service/OSD/Congressional level.

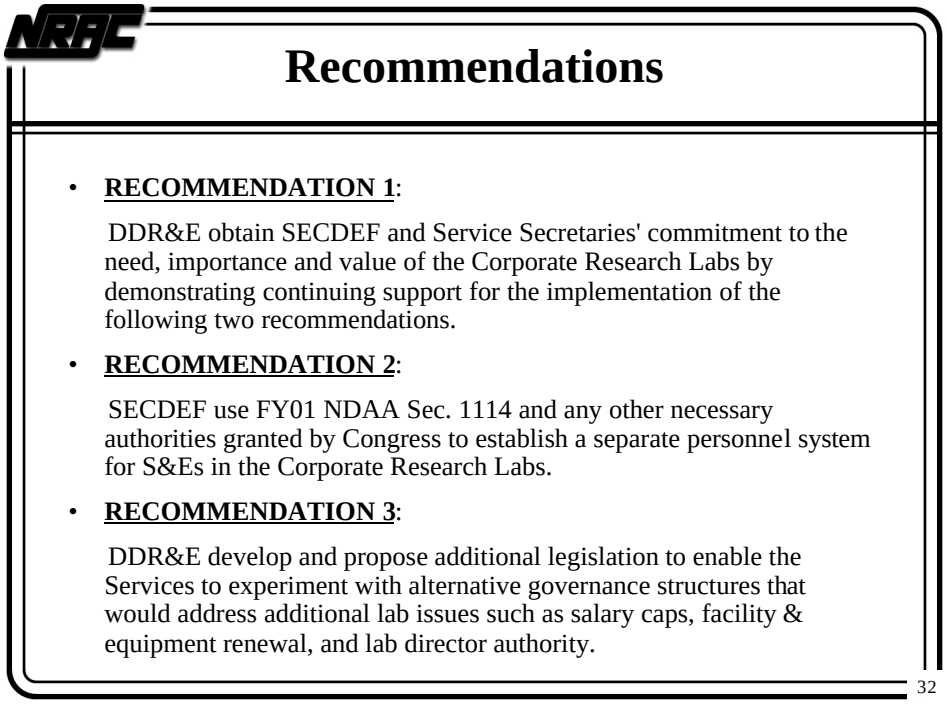
Unfortunately, the fate of these recommendations has been pretty much the same as well -- no action.

The consequences of inaction on the recommendations made by past studies is, unfortunately, evident at most labs. The time has come to listen to the conclusions of the many distinguished people who have served on these past lab studies, and implement actions to remove the burdens of an unresponsive bureaucratic system from one of the most important contributors to US military superiority.

The specific actions to be taken have been adequately documented in the past and are summarized herein.

Congress has even provided the necessary authorities (Sec 1114) to address many of the most important recruitment and retention impediments.

What is needed now is clear recognition that there is a problem and a commitment to fix it!



RECOMMENDATIONS

Recommendation 1:

Reconfirm and advertise the labs as scientific/discovery component of US defense establishment, the DDR&E as the visible, permanent, high-level champion for the labs in OSD, and the SAEs as the same for the Services.

Obtain commitment by SECDEF/DEPSECDEF, USD(AT&L), and the Services to direct staff offices to support reforms.

Recommendation 2:

Sec 1114 gives OPM's authorities to manage S&T lab personnel demos to SECDEF. As urgent item, DOD establish steering & working groups to develop guiding principles and implementing regs for new S&T lab personnel system, and advise Congress that action IRT Sec 1114 is under way.

Proposed Structure:

- Steering Group: Deputy DDR&E, Service Vice Chiefs, Service Acquisition Exec reps, Service S&T Execs
- Working Group members: USD(P&R) rep, DDR&E rep, lab reps; plus full-time contractor support
- Initial focus on three Service S&T labs (including ONR, ARO, AFOSR), with possible later expansion to S&T components in product centers
- Overarching structure with maximum flexibility to accommodate Service differences
- Phased implementation to maximize use of 1114 authority
  - Steps OSD or Services could implement immediately without additional guidance
  - Steps requiring development of implementing guidance
- Proposed Schedule:

- Begin testing and partial implementation (in parallel with old system): Oct 02
- Fully implement at selected sites: Oct 03

Recommendation 3:

Develop possible alternative governance structures for the DOD S&T labs/offices, based on best academic/industrial practices and clean-slate analysis of unique needs of defense labs

Fully develop pros/cons of more radical alternatives requiring new legislation, such as Government-owned corporation, USUHS-like agency, GOCO, separate Title 10 authority for personnel, facilities, etc

Consider such factors as cost, efficiency, responsiveness to defense needs, executability, differing Service requirements, and possible impediments

Develop draft POA&Ms for each possible alternative, candidate lab(s), and differing circumstances

Develop proposed legislative authorities

- Personnel, infrastructure, and bureaucratic regulations
  - Break the link between lab salaries and other government pay
  - Break the link between lab infrastructure renewal and the MILCON process
- Authority of lab directors
- Clear statement of uniqueness of lab requirements

OSD/Service/lab/contractor team led by DDR&E

Include provisions for accommodating Service differences and possible extension to selected parts of product centers

Include measures to ensure:

- Adequate and stable funding
- Quality
- Continuing communication with product centers and operators

Proposed Schedule:

- POA&M: 1 Oct 02
- Review by DDR&E & Services: 1 Jul 03
- Report to SECDEF: 1 Oct 03

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Appendix H

Acronyms

AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Lab
AFSAB	Air Force Science Board
ARL	Army Research Lab
ARO	Army Research Office
ASB	Army Science Board
ASD(FM&P)	Assistant Secretary of Defense (Force Management and Personnel)
BRAC	Base Realignment and Closure
CAN	Center for Naval Analysis
CCS	Credit Category Score
CEO	Chief Executive Officer
CIA	Control Intelligence Agency
CIMS	Center for Innovation Management Studies
CNR	Chief of Naval Research
CP/EEO	Civilian Personnel/Equal Employment Opportunity
CPP	Capitol Purchase Program
CSRA	Civil Service Reform Act
CTO	Chief Technology Officer
CWFP	Changing Workforce Program
DARPA	Defense Advanced Research Products Agency
DASD(CPP)	Deputy Assistant Secretary of Defense (Civilian Personnel Policy)
DAWIA	Defense Acquisiton Warfare Improvement Act
DDR&E	Director, Defense Research and Engineering
DEPSECDEF	Deputy Secretary of Defense
DIA	Defense Intelligence Agency
DMR	Defense Management Review
DMRD	Defense Management Review Decision
DMRDs	Defense Management Review Decision
DNL	Director of Naval Laboratory
DOD	Department of Defense
DOE	Department of Energy
DON	Department of the Navy
DPR	Defence Performance Review
DSB	Defense Science Board
FEPCA	Federal Employees Pay Comparability Act
FFRDCs	Federally Funded Research and Development Centers
FPM	Federal Personnel Manual
FTE	Full Term Equivalent
FY	Fiscal year
GAO	Government Accounting Office

GDP	Gross Domestic Product
GOCO	Government Owned, Contractor Operated
GPS	Global Positioning Systems
GS	General Schedule
HR	Human Resources
ICBM	Intercontinental Ballistic Missile
IPA	Intergovermental Personnel Act
IPS	Integrated Pay Schedule
IRI	Industrial Research Institute
IT	Information Technology
JHU-APL	Johns Hopkins University - Applied Physics Laboratory
LDP	Laboratory Demonstration Program
LQIP	Laboratory Quality Improvement Program
M&R	Maintenance and Repair
MBA	Master of Business Administration
MILCOM	Military Construction
MILSPECS	Military Specifications
NADC	Naval Air Development Center
NAPA	National Academy of Public Administration
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NASA	National Aeronautics and Space Administration
NAWC	Naval Air Warfare Center
NDAA	National Defense Authorization Act
NDAA	National Defense Authorization Act
NIST	National Institute of Standards and Technology
NOSC	Naval Ocean Systems Control
NPR	National Performance Review
NRAC	Naval Research Advisory Committee
NRL	Naval Reasearch Lab
NSA	National Security Agency
NSF	National Science Foundation
NSTC	National Science and Technology Council
NUWC	Naval Undersea Warfare Center
NWC	Naval Weapons Center
O&M	Operations and Maintenance
OMB	Office of Management and Budget
ONR	Office of Naval Research
OOASN	Office of the Deputy Assistant Secretary of the Navy
OPM	Office of Personnel Management
OSD	Office of the Secretary of Defense
PMS	Program Managers
POA&M	Plan of Action and Milestones
PPBS	Planning, Programming and Budgeting Sytem
PPP	Priority Placement Program
PRV	Plant Replacement Value

R&D	Research and Development
RDA	Research, Development and Acquisition
RDEC	Research , Development and Engineering Center
RDT&E	Research, Development, Test and Evaluation
RIF	Reduction in Force
S&Es	Scientists and Engineers
S&T	Science and Technology
SAE	Service Acquisition Executive
SECDEF	Secretary of Defense
SES	Senior Executive Service
SL	Senior Level
SPAWAR	Space and Naval Warfare Systems Center
ST	Science and Technology
T&E	Test and Evaluation
TD	Technical Director
TOR	Terms of Reference
U.S.	United States
UARCS	University-Affiliated Research Centers
USD(A)	Under Secretary of Defense for Acquisiton
USD(AT&L)	Under Secretary of Defense (Acquisition, Technology and Logistics)
USUHS	Uniformed Services University of the Health Sciences
VERA	Voluntary Early Retirement Authority
VP	Vice President
VSIP	Voluntary Separation Incentive Pay
WCF	Working Capital Fund

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